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**Phase Function, Backscatter, Extinction,  
and Absorption for Standard Radiation  
Atmosphere and El Chichon Aerosol Models  
at Visible and Near-Infrared Wavelengths**

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## SUMMARY

Tabular values of phase function, Legendre polynomial coefficients,  $180^\circ$  backscatter, and extinction cross section are given for eight wavelengths in the atmospheric windows between 0.4 and 2.2  $\mu\text{m}$ . Also included are single-scattering albedo, asymmetry factor, and refractive indices. These values are based on Mie theory calculations for the Standard Radiation Atmospheres (continental, maritime, urban, unperturbed stratospheric, volcanic, upper atmospheric, soot, oceanic, dust, and water-soluble) as well as measured volcanic aerosols at several time intervals following the El Chichon eruption. Comparisons of extinction to  $180^\circ$  backscatter for different aerosol models are also presented and related to lidar data.

## INTRODUCTION

Much research has been conducted to characterize the optical properties of various atmospheric layers. Reference 1 presented a series of optical models for a variety of aerosol types which have provided a basis for many radiation and remote sensing studies. Most recently, these models have been refined and designated as Standard Radiation Atmosphere (SRA) aerosol models for purposes of climate studies (ref. 2). In that publication, many physical property and optical parameters are tabulated in a form useful for input to general climate models. Unfortunately, that information is not sufficient for detailed radiative transfer calculations in that single-scattering phase function values are not presented. Such information is required for accurate skylight and lidar backscatter calculations. In addition, the SRA volcanic aerosol does not account for the series of recent volcanic eruptions which have changed particle size characteristics for both aged and recent eruption conditions (refs. 3, 4, and 5). The effect of stratospheric particle size has been shown to produce dramatic changes in aerosol optical parameters (refs. 5 and 6).

This report gives tabular values of phase function, Legendre polynomial coefficients, and  $180^\circ$  backscatter at the 0.40, 0.44, 0.55, 0.75, 1.04, 1.24, 1.65, and 2.20  $\mu\text{m}$  wavelengths. For consistency, extinction cross section, single-scattering albedo, asymmetry factor, and refractive indices are also given. Values are calculated from Mie theory for the continental, maritime, urban, unperturbed stratospheric, volcanic, upper atmospheric, soot, oceanic, dust, and water-soluble SRA aerosol models. Stratospheric values are presented for El Chichon pre-eruption, 1.5-month post-eruption, and 13-month post-eruption conditions over Texas (refs. 4 and 5). Comparisons of extinction to  $180^\circ$  backscatter spectra for different aerosol models are presented and related to ruby lidar experimental data. Backscatter values are also compared at wavelengths near those of a doubled Nd-YAG lidar.

## RESULTS

Appendices A through I give Mie-calculated scattering, extinction, and absorption properties of the SRA aerosol models from this study. (Calculations are based on the reference 7 Mie code which has been modified for polydispersed particle size distributions. Particle size input values were

taken directly from appendix A of reference 2. Index of refraction input values were either taken directly from reference 2 or computed on the basis of mixture percentages given in that document.) Table 1 of each appendix gives optical parameters with appropriate units. Table 2 gives phase function values from 0 to  $180^\circ$  normalized such that the integral of the phase function over a  $4\pi$  sr equals unity as described in reference 8. Table 3 gives Legendre coefficients that may be used to calculate phase function following the approach of reference 9 which normalizes the phase function integral over  $4\pi$  sr to equal  $4\pi$ . Both types of normalizations are used in radiative transfer models. It should be noted that a large number of Legendre coefficients are required for accurate computations of large-particle aerosols (dust, in particular).

One parameter important to the analysis of lidar data is the ratio of aerosol extinction to  $180^\circ$  backscatter. This ratio is obtained from extinction cross section and  $180^\circ$  backscatter in appendices A to I and is presented in figures 1 and 2 for the SRA aerosols. Figure 1 shows both a wide range of values and spectral shapes depending on aerosol type. The boundary layer aerosols (continental, urban, and maritime) have similar spectral trends but differ widely in absolute value. The upper atmospheric aerosol from 30 to 50 km in altitude has a large increase with wavelength, while the unperturbed stratosphere has an opposite trend.

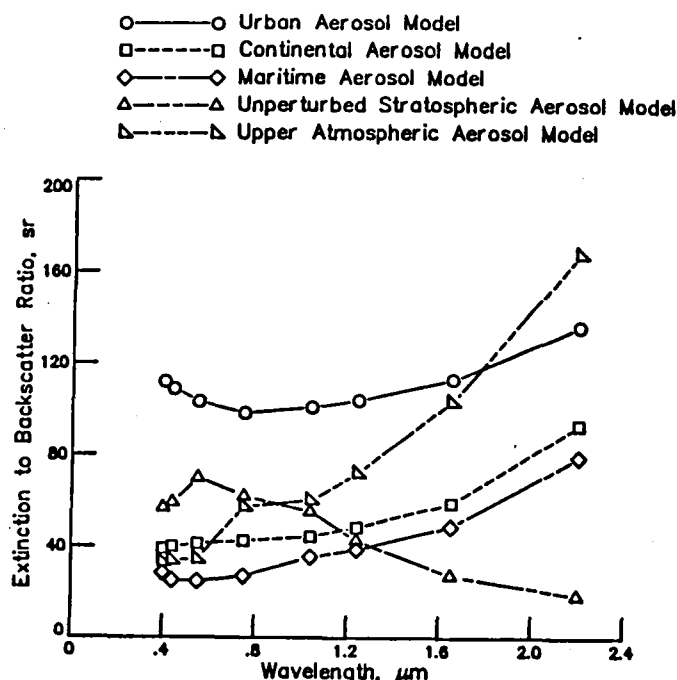


Figure 1.- Extinction to backscatter ratio for several SRA aerosols.

Figure 2 shows extinction to backscatter ratio for the basic SRA aerosol elements (water-soluble, dust, soot, and oceanic). An expanded scale for the extinction to backscatter ratio is required because of the high absorption (low single scattering albedo) of soot which gives low scattering relative to extinction (compare appendices F and H). This suggests that the lidar extinction to  $180^\circ$  backscatter parameter may be quite variable in urban and/or smoke aerosols where soot is present in differing percentages.

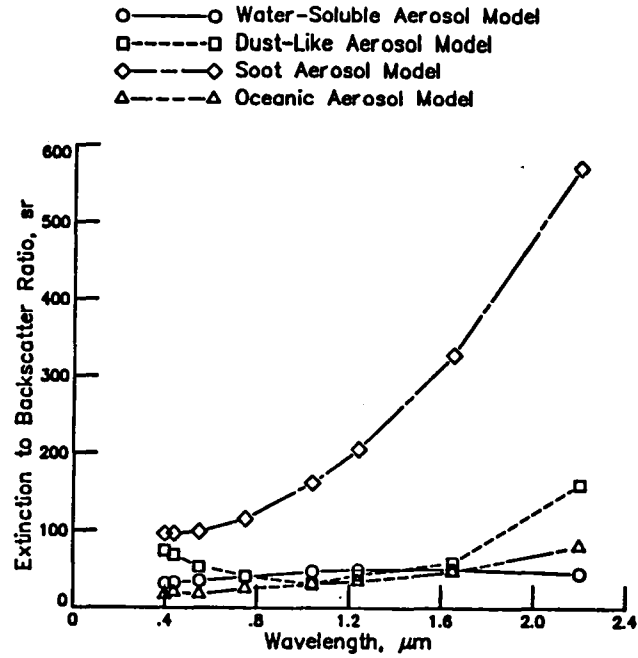


Figure 2.- Extinction to backscatter ratio for basic SRA aerosol types.

Appendices J through M give optical characteristics of several stratospheric aerosols. Size distributions used as a basis for the Mie calculations are shown in figure 3.

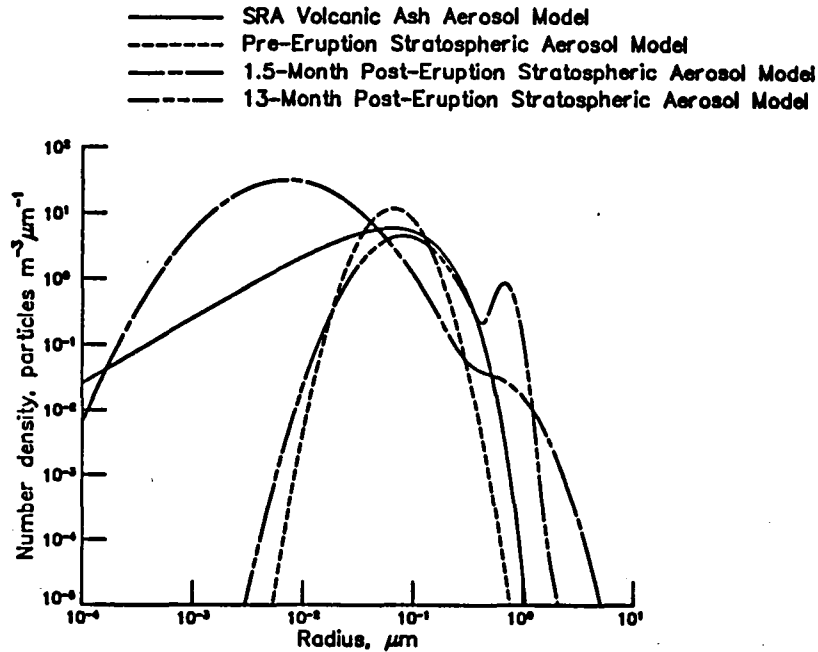


Figure 3.- Volcanic particle size distributions.

The SRA volcanic ash is taken from reference 2. Both pre-eruption and 1.5-month post-eruption El Chichon distributions are dustsonde data from reference 4 after normalization to 1 particle per  $\text{cm}^3$ . The 13-month post-eruption data are taken from unpublished dustsonde data as described in reference 5. (Reference 4 also gives a 7.5-month post eruption size distribution, but its general shape is similar to the 13-month curve.) The initial effect of the El Chichon eruption was a relative increase in both large and small particles. Over the next 13 months, there appears to have been a decrease in small particles (through coagulation and growth), but longer persistence of large particles in the  $1\text{ }\mu\text{m}$  range. This is believed to have been caused by nucleation and growth of  $\text{H}_2\text{SO}_4\text{-H}_2\text{O}$  droplets in the stratosphere (ref. 4). It must be noted that the SRA volcanic ash size distribution is not similar to any of the El Chichon clouds.

Figure 4 shows extinction to backscatter ratio spectra for various stratospheric aerosol models.

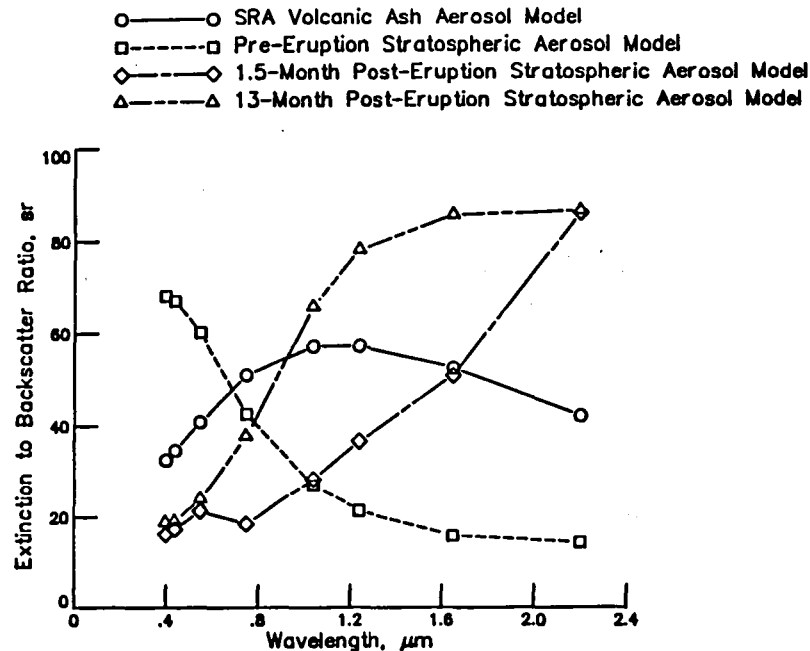


Figure 4.- Extinction to backscatter ratio for stratospheric aerosols.

The El Chichon pre-eruption curve (with few  $1\text{ }\mu\text{m}$  radius particles) decreases with increasing wavelength. Both the 1.5-month and 13-month post-eruption curves have an opposite, increasing with wavelength, trend. Selecting the ruby lidar wavelength ( $0.69\text{ }\mu\text{m}$ ) as an example, extinction to backscatter ratio was approximately 48 sr prior to eruption. A value near 19 sr is calculated 1.5-months after eruption. The 13-month post-eruption curve gives a ratio near 35 sr. (An extinction to backscatter uncertainty of  $\pm 7$  sr is estimated in reference 10 for similar Wyoming dustsonde data.) In spite of uncertainties, the dynamic nature of extinction to backscatter justifies the wisdom of frequent experimental measurements after a volcanic event. Use of the SRA volcanic model in this time period results in large errors (ref. 5).

It must be noted that considerable differences exist in extinction to  $180^\circ$  backscatter values for the background stratosphere. Figure 5 compares the SRA unperturbed stratosphere (fig. 1) with El Chichon pre-eruption values (fig. 4). Differences as large as 20 sr exist depending on wavelength.

Reference 2 describes the need for updating the SRA unperturbed stratosphere mixture, and reference 3 suggests a gradual change as a result of the series of volcanic eruptions since 1978. At the ruby lidar wavelength ( $0.69 \mu\text{m}$ ), reference 10 reports an experimental extinction to backscatter value between 56 and 61 sr over Greenland in November 1978 as typical background stratosphere. Calculations using the pre-eruption size data (ref. 4) suggest that values near 48 sr may be more appropriate at the present time. As early as 1976, reference 11 gave results which show wide variations possible in the non-volcanic stratosphere. Calculations with several combinations of size and index of refraction values gave extinction to backscatter ratios ranging between 50 and 62 sr. The SRA unperturbed stratosphere value (65 sr) is at one end of this range as opposed to that of the pre-eruption value (48 sr). More accurate size and index of refraction data is desirable to reduce uncertainty and to improve the accuracy of climate calculations.

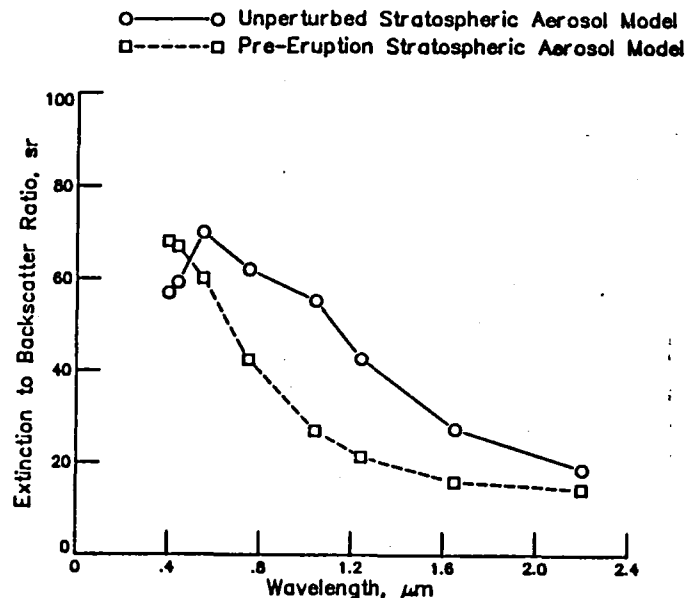


Figure 5.- Extinction to backscatter ratio for background stratosphere.

Another scattering parameter of interest is the ratio of  $180^\circ$  backscatter at  $0.55 \mu\text{m}$  to that at  $1.04 \mu\text{m}$ . The ratio would be representative of the relative backscatter values that would be obtained using a doubled Nd-YAG lidar looking through a hypothetical SRA or volcanic aerosol at the  $0.53$  and  $1.06 \mu\text{m}$  wavelengths. Taking values from appendices A, B, C, F, G, H, and I gives the following backscatter ratio values for various tropospheric aerosols:

<u>Aerosol Model</u>	<u>0.55<math>\mu\text{m}</math>/1.04<math>\mu\text{m}</math> Backscatter</u>
Dust	0.55
Maritime	1.60
Oceanic	1.67
Urban	2.16
Continental	2.50
Water-Soluble	3.27
Soot	3.86

Backscatter ratio values for stratospheric aerosols from appendices D, J, K,

L, and M are as follows:

<u>Aerosol Model</u>	<u>0.55<math>\mu</math>m/1.04<math>\mu</math>m Backscatter</u>
1.5-Month El Chichon	1.19
13-Month El Chichon	1.86
Pre-Eruption	2.33
Unperturbed Stratosphere	2.56
SRA Volcanic	2.56

Both of the above listings suggest that the ratio of  $180^\circ$  backscatter at 0.55  $\mu$ m to that at 1.04  $\mu$ m is a strong function of particle size with a secondary effect of particle absorption. Within an environment where there is a relatively small change in particle indices of refraction (such as the stratosphere), measurement of the above backscatter ratio should provide a clear indication of perturbations from normal conditions and perhaps give a guide to an approximate extinction to backscatter value for use in data analysis from charts such as figure 4. In the troposphere, the ratio should be useful in identifying large amounts of either smoke or dust against background continental or maritime atmospheres. When combined with other measurements and wind data, it should provide a tool which aids in identification of aerosol type.

#### CONCLUDING REMARKS

Phase function, Legendre coefficients, extinction cross section,  $180^\circ$  backscatter, albedo, asymmetry, and refractive indices have been tabulated for various SRA and El Chichon aerosols. These values are an extension to previously published SRA aerosol properties and should be useful for more accurate radiative transfer and lidar backscatter studies. Spectral comparison of extinction to  $180^\circ$  backscatter ratios showed the wide range of values which are possible depending on aerosol type. Variation in the ratio of 0.55  $\mu$ m to 1.04  $\mu$ m backscatter suggests that doubled Nd-YAG lidar measurements may be valuable in both detecting atmospheric perturbations and identifying aerosol types.

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Appendix A  
Continental Aerosol Model

Table A1. Optical Parameters

Wavelength ( $\mu\text{m}$ )	Extinction Cross Section ( $\text{m}^2$ )	Asymmetry Factor	Single Scattering Albedo	180 Degree Backscatter ( $\text{m}^2/\text{sr}$ )	Refractive Indices	
0.40	7.67-16	0.650	0.917	1.96-17	1.53	-1.16-2
0.44	6.98-16	0.646	0.908	1.75-17	1.53	-1.16-2
0.55	5.44-16	0.637	0.911	1.32-17	1.53	-1.17-2
0.75	3.71-16	0.624	0.901	8.70-18	1.53	-1.24-2
1.04	2.35-16	0.614	0.871	5.27-18	1.52	-1.48-2
1.24	1.72-16	0.619	0.851	3.54-18	1.49	-1.56-2
1.65	9.59-17	0.646	0.800	1.62-18	1.41	-1.62-2
2.20	4.93-17	0.731	0.757	5.29-19	1.29	-1.39-2

Table A2. Phase Functions

Scatter Angle (deg)	Wavelength ( $\mu\text{m}$ )							
	0.40	0.44	0.55	0.75	1.04	1.24	1.65	2.20
0	3.83 0	3.54 0	3.00 0	2.48 0	2.18 0	2.16 0	2.30 0	2.83 0
1	3.22 0	3.06 0	2.73 0	2.36 0	2.12 0	2.12 0	2.27 0	2.81 0
2	2.16 0	2.16 0	2.13 0	2.04 0	1.95 0	1.99 0	2.18 0	2.74 0
4	1.32 0	1.29 0	1.26 0	1.32 0	1.46 0	1.59 0	1.88 0	2.48 0
6	1.08 0	1.05 0	1.00 0	9.60-1	1.04 0	1.17 0	1.51 0	2.13 0
8	9.37-1	9.13-1	8.65-1	8.18-1	8.19-1	8.90-1	1.16 0	1.74 0
10	8.26-1	8.08-1	7.69-1	7.22-1	7.08-1	7.36-1	9.11-1	1.38 0
15	6.21-1	6.13-1	5.92-1	5.62-1	5.41-1	5.48-1	6.04-1	8.06-1
20	4.76-1	4.73-1	4.63-1	4.46-1	4.30-1	4.30-1	4.47-1	5.30-1
40	1.74-1	1.75-1	1.77-1	1.78-1	1.77-1	1.74-1	1.64-1	1.35-1
60	6.87-2	6.96-2	7.15-2	7.40-2	7.52-2	7.36-2	6.64-2	4.76-2
80	3.14-2	3.18-2	3.29-2	3.46-2	3.56-2	3.47-2	3.09-2	2.11-2
100	1.78-2	1.81-2	1.88-2	1.99-2	2.07-2	2.04-2	1.82-2	1.29-2
120	1.36-2	1.39-2	1.45-2	1.55-2	1.63-2	1.62-2	1.49-2	1.12-2
140	1.45-2	1.47-2	1.52-2	1.61-2	1.69-2	1.69-2	1.62-2	1.23-2
150	1.64-2	1.66-2	1.69-2	1.75-2	1.84-2	1.85-2	1.81-2	1.31-2
160	1.83-2	1.83-2	1.86-2	1.91-2	2.01-2	2.06-2	2.05-2	1.39-2
170	2.11-2	2.11-2	2.12-2	2.18-2	2.22-2	2.18-2	2.06-2	1.43-2
175	2.52-2	2.50-2	2.46-2	2.44-2	2.42-2	2.28-2	1.97-2	1.36-2
180	2.79-2	2.75-2	2.66-2	2.60-2	2.58-2	2.42-2	2.12-2	1.42-2

Table A3. Legendre Coefficients of Phase Functions

Index	Wavelength ( $\mu\text{m}$ )							
	0.40	0.44	0.55	0.75	1.04	1.24	1.65	2.20
0	1.00 0	1.00 0	1.00 0	1.00 0	1.00 0	1.00 0	1.00 0	1.00 0
1	1.95 0	1.94 0	1.91 0	1.87 0	1.84 0	1.86 0	1.94 0	2.19 0
2	2.21 0	2.18 0	2.12 0	2.04 0	2.00 0	2.05 0	2.26 0	2.84 0
3	1.89 0	1.85 0	1.77 0	1.67 0	1.64 0	1.71 0	2.03 0	2.91 0
4	1.62 0	1.57 0	1.48 0	1.38 0	1.36 0	1.46 0	1.83 0	2.83 0
5	1.32 0	1.28 0	1.19 0	1.11 0	1.12 0	1.23 0	1.63 0	2.66 0
6	1.13 0	1.09 0	1.01 0	9.46-1	9.80-1	1.09 0	1.49 0	2.46 0
7	9.70-1	9.31-1	8.65-1	8.17-1	8.73-1	9.92-1	1.38 0	2.26 0
8	8.67-1	8.32-1	7.76-1	7.46-1	8.14-1	9.29-1	1.29 0	2.06 0
9	7.76-1	7.45-1	6.99-1	6.83-1	7.65-1	8.83-1	1.22 0	1.87 0
10	7.24-1	6.96-1	6.59-1	6.55-1	7.39-1	8.50-1	1.15 0	1.69 0
11	6.65-1	6.41-1	6.13-1	6.20-1	7.10-1	8.24-1	1.10 0	1.53 0
12	6.39-1	6.18-1	5.95-1	6.08-1	6.96-1	7.98-1	1.03 0	1.37 0
13	5.98-1	5.80-1	5.65-1	5.85-1	6.74-1	7.73-1	9.76-1	1.23 0
14	5.86-1	5.71-1	5.58-1	5.80-1	6.61-1	7.51-1	9.12-1	1.08 0
15	5.57-1	5.44-1	5.38-1	5.65-1	6.41-1	7.24-1	8.57-1	9.60-1
16	5.52-1	5.41-1	5.36-1	5.61-1	6.29-1	7.00-1	7.95-1	8.36-1
17	5.30-1	5.21-1	5.19-1	5.48-1	6.09-1	6.70-1	7.37-1	7.30-1
18	5.27-1	5.19-1	5.18-1	5.45-1	5.95-1	6.45-1	6.76-1	6.24-1
19	5.11-1	5.05-1	5.05-1	5.32-1	5.73-1	6.12-1	6.17-1	5.34-1
20	5.08-1	5.03-1	5.03-1	5.25-1	5.57-1	5.84-1	5.60-1	4.49-1
21	4.98-1	4.94-1	4.95-1	5.16-1	5.37-1	5.52-1	5.04-1	3.75-1
22	4.97-1	4.93-1	4.94-1	5.09-1	5.19-1	5.25-1	4.54-1	3.08-1
23	4.90-1	4.87-1	4.88-1	4.99-1	4.98-1	4.92-1	4.02-1	2.45-1
24	4.88-1	4.84-1	4.84-1	4.91-1	4.78-1	4.63-1	3.57-1	1.89-1
25	4.81-1	4.77-1	4.77-1	4.79-1	4.55-1	4.30-1	3.09-1	1.32-1
26	4.77-1	4.72-1	4.71-1	4.68-1	4.32-1	3.99-1	2.69-1	9.02-2
27	4.72-1	4.67-1	4.65-1	4.57-1	4.11-1	3.69-1	2.28-1	4.82-2
28	4.70-1	4.65-1	4.60-1	4.46-1	3.90-1	3.41-1	1.97-1	2.83-2
29	4.68-1	4.63-1	4.57-1	4.37-1	3.71-1	3.15-1	1.65-1	9.07-3
30	4.68-1	4.62-1	4.54-1	4.28-1	3.53-1	2.90-1	1.41-1	6.45-3
31	4.64-1	4.58-1	4.48-1	4.16-1	3.32-1	2.63-1	1.11-1	1.61-3
32	4.59-1	4.54-1	4.40-1	4.02-1	3.10-1	2.36-1	8.81-2	1.31-3
33	4.53-1	4.46-1	4.31-1	3.86-1	2.86-1	2.09-1	6.07-2	-2.00-4
34	4.47-1	4.40-1	4.21-1	3.71-1	2.63-1	1.82-1	4.16-2	-2.69-3
35	4.45-1	4.37-1	4.16-1	3.60-1	2.45-1	1.61-1	2.55-2	-1.86-3
36	4.44-1	4.35-1	4.11-1	3.50-1	2.29-1	1.43-1	1.83-2	-8.44-4
37	4.44-1	4.34-1	4.08-1	3.41-1	2.15-1	1.28-1	1.23-2	1.39-3
38	4.44-1	4.33-1	4.04-1	3.32-1	2.01-1	1.14-1	1.23-2	4.21-3
39	4.38-1	4.27-1	3.95-1	3.17-1	1.81-1	9.59-2	6.56-3	3.14-3
40	4.31-1	4.20-1	3.84-1	3.02-1	1.62-1	7.95-2	3.48-3	1.55-3
41	4.24-1	4.11-1	3.73-1	2.86-1	1.43-1	6.26-2	-1.17-3	-5.64-4
42	4.17-1	4.04-1	3.63-1	2.71-1	1.25-1	4.92-2	-3.86-3	-2.76-3
43	4.16-1	4.01-1	3.58-1	2.62-1	1.14-1	4.12-2	-1.73-3	-8.28-4
44	4.16-1	4.00-1	3.53-1	2.54-1	1.05-1	3.68-2	1.60-3	1.67-3
45	4.14-1	3.98-1	3.48-1	2.45-1	9.56-2	3.09-2	4.05-3	3.61-3
46	4.12-1	3.94-1	3.42-1	2.35-1	8.69-2	2.68-2	5.96-3	5.35-3
47	4.04-1	3.85-1	3.31-1	2.20-1	7.26-2	1.68-2	2.77-3	3.14-3
48	3.96-1	3.76-1	3.19-1	2.05-1	5.96-2	8.93-3	-7.05-4	5.86-4
49	3.89-1	3.69-1	3.09-1	1.92-1	4.90-2	3.37-3	-1.99-3	-3.54-4
50	3.84-1	3.63-1	3.01-1	1.81-1	4.11-2	1.19-3	-2.29-3	-8.36-4

Table A3. Concluded

Index	Wavelength ( $\mu\text{m}$ )							
	0.40	0.44	0.55	0.75	1.04	1.24	1.65	2.20
51	3.83-1	3.60-1	2.96-1	1.74-1	3.71-2	2.84-3	9.53-4	1.40-3
52	3.81-1	3.58-1	2.91-1	1.67-1	3.46-2	5.83-3	4.17-3	3.67-3
53	3.75-1	3.51-1	2.82-1	1.56-1	2.74-2	4.22-3	3.25-3	2.85-3
54	3.68-1	3.43-1	2.72-1	1.44-1	2.06-2	2.13-3	1.40-3	1.49-3
55	3.60-1	3.34-1	2.60-1	1.31-1	1.21-2	-1.75-3	-1.88-3	-9.54-4
56	3.52-1	3.25-1	2.49-1	1.19-1	5.85-3	-4.70-3	-4.49-3	-2.98-3
57	3.49-1	3.22-1	2.44-1	1.13-1	5.80-3	-1.66-3	-1.54-3	-8.66-4
58	3.48-1	3.20-1	2.40-1	1.08-1	7.96-3	2.43-3	2.25-3	1.72-3
59	3.45-1	3.16-1	2.35-1	1.02-1	8.42-3	4.76-3	4.33-3	2.95-3
60	3.40-1	3.10-1	2.28-1	9.54-2	8.27-3	5.72-3	5.14-3	3.26-3
61	3.29-1	2.98-1	2.14-1	8.15-2	9.42-4	-4.38-4	-6.45-4	-1.35-3
62	3.17-1	2.85-1	1.99-1	6.76-2	-6.56-3	-7.29-3	-7.03-3	-6.25-3
63	3.10-1	2.78-1	1.90-1	5.95-2	-8.21-3	-8.40-3	-7.99-3	-6.93-3
64	3.05-1	2.73-1	1.84-1	5.43-2	-7.55-3	-7.61-3	-7.23-3	-6.30-3
65	3.08-1	2.74-1	1.85-1	5.67-2	9.21-4	8.47-4	6.37-4	-3.10-4
66	3.10-1	2.76-1	1.86-1	5.96-2	9.49-3	9.30-3	8.50-3	5.58-3
67	3.04-1	2.69-1	1.78-1	5.33-2	8.64-3	8.45-3	7.65-3	4.78-3
68	2.95-1	2.59-1	1.67-1	4.47-2	5.12-3	5.05-3	4.51-3	2.28-3
69	2.79-1	2.43-1	1.50-1	2.96-2	-5.15-3	-4.98-3	-4.79-3	-4.82-3
70	2.64-1	2.28-1	1.34-1	1.56-2	-1.49-2	-1.45-2	-1.37-2	-1.15-2
71	2.62-1	2.25-1	1.30-1	1.45-2	-1.16-2	-1.12-2	-1.05-2	-8.86-3
72	2.62-1	2.25-1	1.29-1	1.70-2	-5.64-3	-5.35-3	-5.10-3	-4.46-3
73	2.67-1	2.29-1	1.34-1	2.45-2	5.48-3	5.56-3	5.03-3	3.51-3
74	2.70-1	2.32-1	1.37-1	3.12-2	1.52-2	1.52-2	1.40-2	1.06-2
75	2.60-1	2.21-1	1.26-1	2.34-2	1.01-2	1.00-2	9.35-3	7.21-3
76	2.47-1	2.08-1	1.12-1	1.33-2	2.38-3	2.42-3	2.44-3	2.10-3
77	2.32-1	1.92-1	9.67-2	1.19-3	-7.42-3	-7.21-3	-6.40-3	-4.49-3
78	2.20-1	1.79-1	8.37-2	-8.15-3	-1.52-2	-1.49-2	-1.35-2	-9.84-3
79	2.21-1	1.80-1	8.51-2	-2.64-3	-7.75-3	-7.59-3	-6.78-3	-4.54-3
80	2.24-1	1.83-1	8.91-2	5.64-3	1.79-3	1.74-3	1.78-3	2.13-3
81	2.26-1	1.85-1	9.15-2	1.21-2	9.43-3	9.20-3	8.64-3	7.58-3
82	2.25-1	1.84-1	9.13-2	1.64-2	1.46-2	1.43-2	1.35-2	1.15-2
83	2.12-1	1.71-1	7.84-2	7.42-3	6.20-3	6.00-3	5.84-3	5.94-3
84	1.98-1	1.56-1	6.46-2	-2.39-3	-3.23-3	-3.29-3	-2.64-3	-4.05-4
85	1.89-1	1.47-1	5.62-2	-6.56-3	-6.92-3	-6.91-3	-5.95-3	-2.97-3
86	1.83-1	1.41-1	5.12-2	-7.46-3	-7.73-3	-7.77-3	-6.86-3	-3.92-3
87	1.86-1	1.44-1	5.50-2	7.51-4	7.82-4	5.74-4	7.17-4	1.51-3
88	1.88-1	1.46-1	5.90-2	9.01-3	9.21-3	8.87-3	8.24-3	6.92-3
89	1.81-1	1.40-1	5.36-2	7.35-3	7.45-3	7.12-3	6.50-3	5.39-3
90	1.72-1	1.30-1	4.56-2	2.99-3	3.07-3	2.90-3	2.59-3	2.37-3
91	1.59-1	1.18-1	3.41-2	-5.04-3	-5.08-3	-5.05-3	-4.72-3	-3.17-3
92	1.49-1	1.07-1	2.48-2	-1.13-2	-1.16-2	-1.15-2	-1.06-2	-7.77-3
93	1.50-1	1.08-1	2.79-2	-4.64-3	-4.83-3	-4.76-3	-4.48-3	-3.33-3
94	1.53-1	1.12-1	3.36-2	4.27-3	4.10-3	4.00-3	3.47-3	2.24-3
95	1.54-1	1.13-1	3.60-2	9.74-3	9.54-3	9.29-3	8.12-3	5.15-3
96	1.50-1	1.10-1	3.52-2	1.18-2	1.18-2	1.16-2	1.01-2	6.13-3
97	1.34-1	9.37-2	2.03-2	-9.29-4	-1.05-3	-1.04-3	-1.66-3	-3.26-3
98	1.16-1	7.58-2	4.08-3	-1.52-2	-1.54-2	-1.51-2	-1.47-2	-1.33-2
99	1.08-1	6.88-2	-1.00-3	-1.80-2	-1.81-2	-1.77-2	-1.70-2	-1.50-2
100	1.06-1	6.66-2	-1.19-3	-1.64-2	-1.68-2	-1.64-2	-1.58-2	-1.40-2

# Appendix B

## Maritime Aerosol Model

Table B1. Optical Parameters

Wavelength ( $\mu\text{m}$ )	Extinction Cross Section ( $\text{m}^2$ )	Asymmetry Factor	Single Scattering Albedo	180 Degree Backscatter ( $\text{m}^2/\text{sr}$ )	Refractive Indices	
0.40	1.91-15	0.767	0.990	6.70-17	1.39	-2.50-4
0.44	1.87-15	0.764	0.991	7.43-17	1.39	-2.50-4
0.55	1.78-15	0.759	0.991	7.17-17	1.39	-3.00-4
0.75	1.67-15	0.761	0.989	6.14-17	1.38	-4.35-4
1.04	1.60-15	0.766	0.984	4.48-17	1.37	-8.76-4
1.24	1.56-15	0.766	0.984	3.99-17	1.37	-1.08-3
1.65	1.45-15	0.773	0.984	2.97-17	1.36	-1.28-3
2.20	1.27-15	0.786	0.987	1.61-17	1.34	-1.33-3

Table B2. Phase Functions

Scatter Angle (deg)	Wavelength ( $\mu\text{m}$ )							
	0.40	0.44	0.55	0.75	1.04	1.24	1.65	2.20
0	3.12 1	2.69 1	1.89 1	1.16 1	6.89 0	5.43 0	3.75 0	2.71 0
1	2.54 1	2.27 1	1.69 1	1.09 1	6.69 0	5.32 0	3.71 0	2.69 0
2	1.47 1	1.43 1	1.24 1	9.17 0	6.12 0	4.99 0	3.58 0	2.64 0
4	4.82 0	4.93 0	5.07 0	5.10 0	4.40 0	3.94 0	3.12 0	2.45 0
6	2.39 0	2.45 0	2.61 0	2.77 0	2.85 0	2.79 0	2.53 0	2.17 0
8	1.47 0	1.51 0	1.62 0	1.78 0	1.91 0	1.94 0	1.96 0	1.85 0
10	1.04 0	1.07 0	1.13 0	1.25 0	1.39 0	1.42 0	1.50 0	1.54 0
15	5.98-1	6.05-1	6.20-1	6.97-1	7.66-1	7.99-1	8.70-1	9.47-1
20	4.17-1	4.14-1	4.22-1	4.42-1	4.87-1	5.10-1	5.53-1	6.08-1
40	1.24-1	1.24-1	1.24-1	1.21-1	1.22-1	1.24-1	1.27-1	1.30-1
60	4.14-2	4.19-2	4.21-2	4.05-2	3.98-2	3.94-2	3.86-2	3.72-2
80	1.59-2	1.60-2	1.62-2	1.69-2	1.59-2	1.58-2	1.53-2	1.44-2
100	8.69-3	8.76-3	8.75-3	8.80-3	8.76-3	8.74-3	8.58-3	7.99-3
120	6.38-3	6.67-3	7.08-3	6.90-3	7.30-3	7.28-3	7.23-3	6.89-3
140	9.69-3	1.04-2	1.14-2	1.09-2	1.15-2	1.13-2	1.06-2	9.27-3
150	1.98-2	2.03-2	1.94-2	1.93-2	1.71-2	1.62-2	1.41-2	1.13-2
160	2.34-2	2.24-2	2.49-2	2.32-2	2.10-2	2.03-2	1.76-2	1.33-2
170	2.81-2	2.94-2	2.87-2	2.85-2	2.37-2	2.20-2	1.78-2	1.17-2
175	3.18-2	3.16-2	3.27-2	2.63-2	1.98-2	1.72-2	1.41-2	1.04-2
180	3.54-2	4.00-2	4.07-2	3.72-2	2.85-2	2.61-2	2.08-2	1.28-2

Table B3. Legendre Coefficients of Phase Functions

Index	Wavelength ( $\mu\text{m}$ )							
	0.40	0.44	0.55	0.75	1.04	1.24	1.65	2.20
0	1.00 0	1.00 0	1.00 0	1.00 0	1.00 0	1.00 0	1.00 0	1.00 0
1	2.30 0	2.29 0	2.28 0	2.28 0	2.30 0	2.30 0	2.32 0	2.36 0
2	3.22 0	3.22 0	3.19 0	3.19 0	3.19 0	3.17 0	3.16 0	3.16 0
3	3.42 0	3.41 0	3.37 0	3.37 0	3.36 0	3.32 0	3.29 0	3.29 0
4	3.75 0	3.74 0	3.69 0	3.66 0	3.53 0	3.44 0	3.32 0	3.20 0
5	3.84 0	3.83 0	3.75 0	3.69 0	3.48 0	3.34 0	3.14 0	2.93 0
6	4.06 0	4.05 0	3.94 0	3.77 0	3.46 0	3.26 0	2.95 0	2.63 0
7	4.26 0	4.25 0	4.09 0	3.84 0	3.42 0	3.16 0	2.76 0	2.33 0
8	4.43 0	4.40 0	4.22 0	3.87 0	3.34 0	3.03 0	2.55 0	2.03 0
9	4.65 0	4.60 0	4.36 0	3.93 0	3.29 0	2.94 0	2.37 0	1.78 0
10	4.82 0	4.77 0	4.46 0	3.93 0	3.20 0	2.81 0	2.17 0	1.54 0
11	4.99 0	4.90 0	4.57 0	3.95 0	3.12 0	2.71 0	2.01 0	1.34 0
12	5.18 0	5.07 0	4.67 0	3.95 0	3.03 0	2.59 0	1.83 0	1.14 0
13	5.28 0	5.14 0	4.72 0	3.92 0	2.94 0	2.47 0	1.69 0	9.88-1
14	5.43 0	5.27 0	4.77 0	3.89 0	2.83 0	2.34 0	1.53 0	8.29-1
15	5.51 0	5.33 0	4.79 0	3.84 0	2.73 0	2.23 0	1.40 0	7.08-1
16	5.61 0	5.41 0	4.80 0	3.78 0	2.61 0	2.10 0	1.26 0	5.84-1
17	5.67 0	5.46 0	4.81 0	3.72 0	2.51 0	1.98 0	1.14 0	4.88-1
18	5.72 0	5.49 0	4.80 0	3.64 0	2.39 0	1.86 0	1.02 0	3.94-1
19	5.77 0	5.53 0	4.79 0	3.58 0	2.28 0	1.74 0	9.19-1	3.18-1
20	5.80 0	5.52 0	4.76 0	3.49 0	2.16 0	1.62 0	8.18-1	2.55-1
21	5.82 0	5.53 0	4.71 0	3.43 0	2.05 0	1.51 0	7.25-1	2.00-1
22	5.82 0	5.51 0	4.65 0	3.33 0	1.94 0	1.40 0	6.41-1	1.62-1
23	5.81 0	5.50 0	4.58 0	3.25 0	1.84 0	1.30 0	5.59-1	1.22-1
24	5.81 0	5.48 0	4.51 0	3.16 0	1.73 0	1.20 0	4.91-1	1.01-1
25	5.79 0	5.45 0	4.44 0	3.06 0	1.63 0	1.10 0	4.19-1	6.71-2
26	5.77 0	5.42 0	4.38 0	2.97 0	1.53 0	1.01 0	3.65-1	5.76-2
27	5.74 0	5.38 0	4.30 0	2.87 0	1.43 0	9.15-1	2.99-1	2.66-2
28	5.71 0	5.34 0	4.24 0	2.78 0	1.34 0	8.38-1	2.56-1	2.59-2
29	5.68 0	5.28 0	4.15 0	2.66 0	1.24 0	7.50-1	1.95-1	5.01-3
30	5.63 0	5.23 0	4.08 0	2.56 0	1.16 0	6.84-1	1.62-1	7.94-3
31	5.59 0	5.17 0	3.99 0	2.44 0	1.07 0	6.02-1	1.08-1	-3.88-4
32	5.53 0	5.11 0	3.90 0	2.35 0	9.94-1	5.46-1	8.86-2	9.61-4
33	5.49 0	5.04 0	3.82 0	2.23 0	9.10-1	4.71-1	4.84-2	-7.56-6
34	5.42 0	4.98 0	3.73 0	2.15 0	8.42-1	4.23-1	4.15-2	-5.67-4
35	5.37 0	4.91 0	3.65 0	2.04 0	7.66-1	3.58-1	1.65-2	4.22-5
36	5.30 0	4.83 0	3.56 0	1.95 0	7.07-1	3.17-1	1.85-2	-7.85-5
37	5.24 0	4.75 0	3.48 0	1.85 0	6.38-1	2.62-1	4.73-3	6.55-5
38	5.18 0	4.67 0	3.38 0	1.76 0	5.86-1	2.29-1	9.42-3	5.81-4
39	5.11 0	4.58 0	3.30 0	1.66 0	5.25-1	1.85-1	1.48-3	3.39-4
40	5.04 0	4.50 0	3.20 0	1.58 0	4.80-1	1.59-1	4.59-3	2.20-4
41	4.97 0	4.41 0	3.12 0	1.50 0	4.26-1	1.26-1	8.35-5	7.69-5
42	4.90 0	4.33 0	3.03 0	1.42 0	3.87-1	1.08-1	1.30-3	-3.16-4
43	4.83 0	4.25 0	2.95 0	1.35 0	3.41-1	8.31-2	-2.47-4	-9.20-5
44	4.76 0	4.17 0	2.85 0	1.28 0	3.09-1	7.23-2	2.67-4	1.83-4
45	4.68 0	4.08 0	2.77 0	1.21 0	2.69-1	5.12-2	2.43-4	3.73-4
46	4.60 0	4.00 0	2.67 0	1.15 0	2.41-1	4.48-2	3.47-4	6.88-4
47	4.53 0	3.92 0	2.59 0	1.07 0	2.05-1	2.69-2	3.21-4	4.99-4
48	4.45 0	3.84 0	2.50 0	1.01 0	1.79-1	2.35-2	1.23-4	2.18-4
49	4.37 0	3.76 0	2.41 0	9.45-1	1.47-1	1.07-2	8.26-5	1.05-4
50	4.29 0	3.67 0	2.33 0	8.87-1	1.26-1	9.99-3	1.51-4	-2.52-5

Table B3. Continued

Index	Wavelength ( $\mu\text{m}$ )							
	0.40	0.44	0.55	0.75	1.04	1.24	1.65	2.20
51	4.21 0	3.59 0	2.25 0	8.28-1	9.82-2	2.97-3	2.75-4	1.53-4
52	4.13 0	3.50 0	2.17 0	7.76-1	8.28-2	3.92-3	4.47-4	4.11-4
53	4.05 0	3.42 0	2.08 0	7.23-1	6.13-2	6.75-4	2.69-4	3.48-4
54	3.97 0	3.33 0	2.01 0	6.73-1	5.11-2	1.40-3	2.53-5	2.51-4
55	3.89 0	3.25 0	1.92 0	6.24-1	3.54-2	-5.47-5	-1.85-4	1.45-5
56	3.82 0	3.17 0	1.85 0	5.77-1	2.99-2	2.35-4	-3.13-4	-2.11-4
57	3.74 0	3.09 0	1.77 0	5.31-1	1.90-2	-1.19-4	1.22-5	-5.23-5
58	3.66 0	3.01 0	1.71 0	4.90-1	1.73-2	3.59-4	4.04-4	1.62-4
59	3.58 0	2.93 0	1.63 0	4.47-1	9.25-3	2.05-4	5.46-4	2.54-4
60	3.51 0	2.86 0	1.57 0	4.11-1	9.05-3	3.18-4	5.35-4	2.40-4
61	3.43 0	2.78 0	1.50 0	3.71-1	2.83-3	-1.99-4	-2.51-5	-2.18-4
62	3.35 0	2.71 0	1.44 0	3.40-1	2.80-3	-6.42-4	-6.25-4	-7.00-4
63	3.28 0	2.63 0	1.37 0	3.05-1	-4.24-4	-6.11-4	-7.29-4	-7.60-4
64	3.20 0	2.55 0	1.31 0	2.80-1	2.59-4	-4.69-4	-6.23-4	-6.30-4
65	3.13 0	2.48 0	1.25 0	2.49-1	-1.79-4	2.54-4	7.72-5	-8.34-6
66	3.05 0	2.41 0	1.20 0	2.30-1	7.81-4	8.81-4	7.57-4	5.80-4
67	2.98 0	2.33 0	1.13 0	2.02-1	5.35-4	8.23-4	7.28-4	4.99-4
68	2.91 0	2.26 0	1.08 0	1.86-1	2.94-4	5.29-4	4.35-4	1.71-4
69	2.84 0	2.19 0	1.03 0	1.59-1	-6.29-4	-2.23-4	-3.69-4	-5.79-4
70	2.76 0	2.12 0	9.79-1	1.46-1	-1.32-3	-8.86-4	-1.10-3	-1.22-3
71	2.69 0	2.06 0	9.29-1	1.22-1	-1.31-3	-5.76-4	-8.86-4	-9.38-4
72	2.62 0	1.99 0	8.82-1	1.11-1	-6.84-4	-5.66-5	-4.03-4	-3.69-4
73	2.55 0	1.93 0	8.35-1	9.05-2	1.32-4	8.65-4	5.07-4	5.39-4
74	2.48 0	1.87 0	7.90-1	8.19-2	1.06-3	1.57-3	1.26-3	1.28-3
75	2.42 0	1.80 0	7.43-1	6.30-2	9.19-4	1.23-3	9.96-4	9.86-4
76	2.35 0	1.74 0	7.00-1	5.57-2	4.69-4	6.25-4	4.50-4	4.18-4
77	2.28 0	1.68 0	6.56-1	3.99-2	-6.28-5	-1.57-4	-2.76-4	-3.10-4
78	2.21 0	1.62 0	6.16-1	3.57-2	-5.82-4	-7.07-4	-8.14-4	-8.20-4
79	2.15 0	1.56 0	5.77-1	2.45-2	1.54-5	-2.03-4	-3.12-4	-2.86-4
80	2.08 0	1.51 0	5.42-1	2.41-2	7.69-4	5.27-4	4.10-4	4.65-4
81	2.02 0	1.45 0	5.06-1	1.54-2	1.41-3	1.15-3	1.03-3	1.13-3
82	1.96 0	1.39 0	4.74-1	1.63-2	1.90-3	1.55-3	1.46-3	1.54-3
83	1.90 0	1.34 0	4.37-1	8.24-3	1.43-3	9.71-4	9.27-4	1.01-3
84	1.84 0	1.29 0	4.09-1	8.76-3	8.56-4	3.15-4	3.17-4	3.65-4
85	1.78 0	1.23 0	3.75-1	2.90-3	6.58-4	-6.28-5	-1.26-6	1.58-5
86	1.72 0	1.18 0	3.51-1	4.11-3	5.42-4	-1.27-4	-4.27-5	-6.54-5
87	1.66 0	1.13 0	3.21-1	1.27-3	1.12-3	3.90-4	4.73-4	4.43-4
88	1.60 0	1.09 0	3.01-1	2.79-3	1.54-3	9.51-4	1.01-3	9.55-4
89	1.55 0	1.04 0	2.74-1	1.13-3	1.36-3	8.65-4	8.81-4	8.55-4
90	1.49 0	1.00 0	2.55-1	1.25-3	9.21-4	5.66-4	5.57-4	5.19-4
91	1.44 0	9.55-1	2.29-1	2.18-4	2.48-4	2.36-5	-1.73-6	-4.26-5
92	1.39 0	9.13-1	2.12-1	-1.62-4	-2.24-4	-3.63-4	-3.98-4	-4.47-4
93	1.34 0	8.71-1	1.88-1	1.87-4	1.17-4	5.55-5	3.30-5	-6.64-5
94	1.29 0	8.32-1	1.74-1	7.07-4	6.63-4	6.79-4	6.32-4	5.02-4
95	1.24 0	7.91-1	1.51-1	1.01-3	9.07-4	9.88-4	9.17-4	7.74-4
96	1.19 0	7.55-1	1.39-1	1.12-3	8.08-4	1.03-3	9.07-4	7.44-4
97	1.14 0	7.16-1	1.18-1	1.08-4	-2.43-4	1.13-4	-6.39-5	-2.06-4
98	1.09 0	6.82-1	1.08-1	-7.27-4	-1.42-3	-9.30-4	-1.14-3	-1.25-3
99	1.05 0	6.45-1	9.00-2	-1.18-3	-1.73-3	-1.08-3	-1.32-3	-1.45-3
100	1.01 0	6.15-1	8.28-2	-9.39-4	-1.54-3	-8.89-4	-1.13-3	-1.21-3

Table B3. Concluded

Index	Wavelength ( $\mu\text{m}$ )							
	0.40	0.44	0.55	0.75	1.04	1.24	1.65	2.20
101	9.63-1	5.82-1	6.91-2	-1.20-4	-3.88-4	3.56-4	1.43-4	9.82-6
102	9.25-1	5.54-1	6.41-2	8.13-4	9.24-4	1.54-3	1.36-3	1.21-3
103	8.82-1	5.22-1	5.17-2	4.48-4	8.17-4	1.44-3	1.28-3	1.14-3
104	8.44-1	4.95-1	4.61-2	-4.76-4	3.43-4	8.25-4	6.92-4	5.37-4
105	8.03-1	4.63-1	3.48-2	-1.78-3	-1.05-3	-6.19-4	-7.56-4	-8.88-4
106	7.66-1	4.37-1	3.01-2	-3.18-3	-2.31-3	-1.97-3	-2.08-3	-2.17-3
107	7.28-1	4.08-1	2.29-2	-2.25-3	-1.80-3	-1.54-3	-1.63-3	-1.74-3
108	6.97-1	3.86-1	2.16-2	-1.13-3	-7.55-4	-6.37-4	-6.95-4	-7.63-4
109	6.62-1	3.60-1	1.73-2	1.02-3	9.48-4	9.54-4	9.44-4	8.71-4
110	6.33-1	3.41-1	1.69-2	2.63-3	2.52-3	2.30-3	2.33-3	2.25-3
111	5.98-1	3.15-1	1.15-2	2.35-3	2.11-3	1.71-3	1.79-3	1.76-3
112	5.68-1	2.94-1	9.11-3	1.51-3	1.28-3	7.07-4	7.95-4	7.67-4
113	5.34-1	2.69-1	3.84-3	1.58-4	1.63-4	-6.43-4	-5.35-4	-5.31-4
114	5.07-1	2.51-1	2.33-3	-7.44-4	-7.78-4	-1.59-3	-1.50-3	-1.48-3
115	4.77-1	2.30-1	3.70-4	-1.56-5	3.32-4	-6.84-4	-5.95-4	-6.01-4
116	4.53-1	2.16-1	1.89-3	1.17-3	1.50-3	6.25-4	6.86-4	6.84-4
117	4.26-1	1.98-1	1.03-3	2.06-3	2.72-3	1.74-3	1.80-3	1.82-3
118	4.04-1	1.85-1	2.18-3	2.56-3	3.32-3	2.51-3	2.53-3	2.55-3
119	3.76-1	1.66-1	-1.70-4	1.42-3	2.36-3	1.59-3	1.60-3	1.68-3
120	3.53-1	1.53-1	-1.04-3	1.48-4	1.17-3	5.34-4	5.03-4	5.84-4
121	3.28-1	1.35-1	-2.48-3	-5.14-4	5.04-4	4.34-6	-6.85-5	9.48-6
122	3.08-1	1.25-1	-2.51-3	-6.63-4	3.05-4	-6.99-5	-1.86-4	-1.48-4
123	2.86-1	1.10-1	-1.90-3	3.27-4	1.03-3	9.06-4	7.11-4	6.94-4
124	2.69-1	1.03-1	-9.45-4	1.22-3	1.84-3	1.84-3	1.62-3	1.55-3
125	2.47-1	8.90-2	-1.13-3	1.19-3	1.44-3	1.73-3	1.44-3	1.37-3
126	2.31-1	8.13-2	-1.66-3	5.49-4	7.53-4	1.16-3	8.97-4	8.31-4
127	2.10-1	6.82-2	-2.60-3	-3.33-4	-3.89-4	2.44-4	-4.70-5	-8.69-5
128	1.95-1	6.18-2	-3.21-3	-1.12-3	-1.17-3	-5.30-4	-7.25-4	-7.65-4
129	1.77-1	5.20-2	-2.45-3	-4.18-4	-5.90-4	1.23-4	-4.56-5	-1.17-4
130	1.66-1	4.83-2	-1.42-3	5.51-4	4.21-4	1.01-3	9.40-4	7.82-4
131	1.49-1	4.00-2	-7.37-4	1.11-3	9.41-4	1.46-3	1.43-3	1.22-3
132	1.38-1	3.61-2	-8.86-4	1.23-3	1.09-3	1.46-3	1.46-3	1.17-3
133	1.22-1	2.69-2	-2.28-3	-2.59-4	-3.57-4	-1.27-4	-8.76-5	-3.88-4
134	1.10-1	2.22-2	-4.32-3	-1.83-3	-1.98-3	-1.81-3	-1.80-3	-2.06-3
135	9.62-2	1.53-2	-4.53-3	-2.17-3	-2.19-3	-2.18-3	-2.11-3	-2.40-3



Appendix C  
Urban Aerosol Model

Table C1. Optical Parameters

Wavelength ( $\mu\text{m}$ )	Extinction Cross Section ( $\text{m}^2$ )	Asymmetry Factor	Single Scattering Albedo	180 Degree Backscatter ( $\text{m}^2/\text{sr}$ )	Refractive Indices	
0.40	6.87-16	0.634	0.584	6.14-18	1.58	-1.06-1
0.44	6.21-16	0.628	0.578	5.70-18	1.58	-1.05-1
0.55	4.80-16	0.615	0.570	4.66-18	1.58	-1.02-1
0.75	3.30-16	0.598	0.547	3.34-18	1.58	-1.01-1
1.04	2.18-16	0.580	0.489	2.16-18	1.57	-1.08-1
1.24	1.73-16	0.570	0.448	1.67-18	1.56	-1.12-1
1.65	1.16-16	0.554	0.373	1.03-18	1.53	-1.17-1
2.20	7.58-17	0.544	0.280	5.59-19	1.47	-1.17-1

Table C2. Phase Functions

Scatter Angle (deg)	Wavelength ( $\mu\text{m}$ )							
	0.40	0.44	0.55	0.75	1.04	1.24	1.65	2.20
0	1.75 0	1.64 0	1.41 0	1.17 0	1.01 0	9.47-1	8.77-1	8.65-1
1	1.65 0	1.55 0	1.36 0	1.15 0	9.99-1	9.38-1	8.72-1	8.62-1
2	1.45 0	1.38 0	1.25 0	1.09 0	9.67-1	9.15-1	8.56-1	8.51-1
4	1.19 0	1.14 0	1.04 0	9.38-1	8.67-1	8.36-1	8.02-1	8.10-1
6	1.03 0	9.95-1	9.19-1	8.28-1	7.67-1	7.47-1	7.31-1	7.51-1
8	9.02-1	8.77-1	8.21-1	7.50-1	6.92-1	6.71-1	6.59-1	6.84-1
10	7.97-1	7.79-1	7.37-1	6.82-1	6.35-1	6.14-1	5.96-1	6.17-1
15	5.97-1	5.89-1	5.70-1	5.42-1	5.14-1	5.01-1	4.83-1	4.82-1
20	4.57-1	4.54-1	4.46-1	4.33-1	4.18-1	4.10-1	3.97-1	3.91-1
40	1.74-1	1.75-1	1.77-1	1.79-1	1.81-1	1.80-1	1.79-1	1.76-1
60	7.37-2	7.44-2	7.61-2	7.86-2	8.08-2	8.17-2	8.24-2	8.13-2
80	3.52-2	3.57-2	3.69-2	3.85-2	4.00-2	4.08-2	4.16-2	4.15-2
100	2.05-2	2.09-2	2.18-2	2.30-2	2.42-2	2.49-2	2.58-2	2.64-2
120	1.56-2	1.60-2	1.68-2	1.79-2	1.92-2	2.00-2	2.13-2	2.25-2
140	1.46-2	1.50-2	1.60-2	1.73-2	1.87-2	1.97-2	2.15-2	2.34-2
150	1.45-2	1.50-2	1.60-2	1.74-2	1.91-2	2.01-2	2.22-2	2.44-2
160	1.44-2	1.49-2	1.60-2	1.75-2	1.94-2	2.06-2	2.28-2	2.53-2
170	1.48-2	1.53-2	1.65-2	1.80-2	1.99-2	2.11-2	2.34-2	2.60-2
175	1.51-2	1.57-2	1.68-2	1.84-2	2.02-2	2.14-2	2.37-2	2.62-2
180	1.53-2	1.59-2	1.70-2	1.86-2	2.03-2	2.15-2	2.38-2	2.63-2

Table C3. Legendre Coefficients of Phase Functions

Index	Wavelength ( $\mu\text{m}$ )							
	0.40	0.44	0.55	0.75	1.04	1.24	1.65	2.20
0	1.00 0	1.00 0	1.00 0	1.00 0	1.00 0	1.00 0	1.00 0	1.00 0
1	1.90 0	1.88 0	1.85 0	1.79 0	1.74 0	1.71 0	1.66 0	1.63 0
2	2.04 0	2.01 0	1.94 0	1.85 0	1.77 0	1.73 0	1.68 0	1.68 0
3	1.74 0	1.70 0	1.61 0	1.48 0	1.37 0	1.31 0	1.26 0	1.27 0
4	1.44 0	1.39 0	1.28 0	1.14 0	1.03 0	9.77-1	9.26-1	9.52-1
5	1.18 0	1.13 0	1.02 0	8.85-1	7.76-1	7.32-1	6.91-1	7.28-1
6	9.85-1	9.36-1	8.27-1	6.96-1	5.99-1	5.62-1	5.32-1	5.76-1
7	8.32-1	7.84-1	6.81-1	5.59-1	4.75-1	4.45-1	4.24-1	4.70-1
8	7.15-1	6.69-1	5.72-1	4.62-1	3.89-1	3.63-1	3.50-1	3.93-1
9	6.19-1	5.76-1	4.86-1	3.86-1	3.24-1	3.03-1	2.97-1	3.34-1
10	5.46-1	5.06-1	4.22-1	3.32-1	2.78-1	2.62-1	2.57-1	2.89-1
11	4.82-1	4.44-1	3.67-1	2.87-1	2.41-1	2.28-1	2.26-1	2.50-1
12	4.33-1	3.98-1	3.27-1	2.55-1	2.14-1	2.04-1	2.01-1	2.18-1
13	3.89-1	3.56-1	2.91-1	2.26-1	1.92-1	1.83-1	1.80-1	1.90-1
14	3.54-1	3.23-1	2.64-1	2.05-1	1.75-1	1.67-1	1.62-1	1.65-1
15	3.22-1	2.94-1	2.39-1	1.86-1	1.60-1	1.52-1	1.46-1	1.42-1
16	2.96-1	2.70-1	2.19-1	1.72-1	1.48-1	1.40-1	1.32-1	1.21-1
17	2.73-1	2.48-1	2.01-1	1.58-1	1.36-1	1.29-1	1.19-1	1.02-1
18	2.53-1	2.30-1	1.87-1	1.47-1	1.27-1	1.20-1	1.07-1	8.57-2
19	2.35-1	2.13-1	1.73-1	1.37-1	1.18-1	1.11-1	9.62-2	7.03-2
20	2.19-1	1.99-1	1.62-1	1.29-1	1.11-1	1.03-1	8.59-2	5.68-2
21	2.05-1	1.87-1	1.52-1	1.22-1	1.04-1	9.52-2	7.64-2	4.49-2
22	1.93-1	1.76-1	1.44-1	1.15-1	9.76-2	8.83-2	6.76-2	3.47-2
23	1.82-1	1.66-1	1.36-1	1.09-1	9.17-2	8.18-2	5.94-2	2.59-2
24	1.72-1	1.57-1	1.29-1	1.04-1	8.61-2	7.55-2	5.17-2	1.86-2
25	1.63-1	1.49-1	1.23-1	9.84-2	8.06-2	6.94-2	4.44-2	1.25-2
26	1.55-1	1.41-1	1.17-1	9.35-2	7.54-2	6.36-2	3.76-2	7.75-3
27	1.48-1	1.35-1	1.12-1	8.91-2	7.06-2	5.82-2	3.17-2	4.51-3
28	1.41-1	1.29-1	1.07-1	8.51-2	6.61-2	5.32-2	2.63-2	2.36-3
29	1.35-1	1.24-1	1.03-1	8.15-2	6.21-2	4.87-2	2.18-2	1.37-3
30	1.30-1	1.19-1	9.90-2	7.82-2	5.83-2	4.45-2	1.79-2	1.02-3
31	1.25-1	1.15-1	9.52-2	7.47-2	5.42-2	4.01-2	1.41-2	5.82-4
32	1.20-1	1.10-1	9.16-2	7.13-2	5.03-2	3.59-2	1.07-2	2.94-4
33	1.15-1	1.06-1	8.78-2	6.77-2	4.62-2	3.17-2	7.55-3	-1.88-4
34	1.11-1	1.02-1	8.44-2	6.43-2	4.23-2	2.77-2	4.89-3	-6.36-4
35	1.07-1	9.86-2	8.16-2	6.16-2	3.91-2	2.45-2	3.32-3	-4.42-4
36	1.04-1	9.57-2	7.91-2	5.91-2	3.62-2	2.17-2	2.25-3	-1.95-4
37	1.01-1	9.31-2	7.69-2	5.69-2	3.37-2	1.93-2	1.80-3	3.03-4
38	9.87-2	9.07-2	7.48-2	5.47-2	3.12-2	1.71-2	1.63-3	8.03-4
39	9.55-2	8.77-2	7.21-2	5.19-2	2.82-2	1.44-2	9.03-4	4.85-4
40	9.24-2	8.48-2	6.94-2	4.91-2	2.52-2	1.18-2	2.89-4	1.27-4
41	8.93-2	8.19-2	6.66-2	4.62-2	2.22-2	9.28-3	-3.03-4	-3.19-4
42	8.65-2	7.92-2	6.41-2	4.35-2	1.95-2	7.10-3	-7.69-4	-7.56-4
43	8.45-2	7.74-2	6.24-2	4.17-2	1.77-2	5.94-3	-3.56-4	-3.22-4
44	8.27-2	7.57-2	6.08-2	4.00-2	1.62-2	5.09-3	1.57-4	1.63-4
45	8.09-2	7.40-2	5.92-2	3.83-2	1.46-2	4.30-3	5.41-4	5.18-4
46	7.91-2	7.23-2	5.76-2	3.65-2	1.31-2	3.62-3	8.55-4	8.52-4
47	7.67-2	7.00-2	5.53-2	3.40-2	1.10-2	2.34-3	3.53-4	3.44-4
48	7.43-2	6.77-2	5.30-2	3.16-2	8.96-3	1.18-3	-1.92-4	-1.69-4
49	7.23-2	6.57-2	5.10-2	2.95-2	7.41-3	5.35-4	-3.71-4	-3.32-4
50	7.04-2	6.39-2	4.92-2	2.77-2	6.11-3	1.33-4	-4.61-4	-4.25-4

Table C3. Concluded

Index	Wavelength ( $\mu\text{m}$ )							
	0.40	0.44	0.55	0.75	1.04	1.24	1.65	2.20
51	6.92-2	6.27-2	4.80-2	2.65-2	5.49-3	4.02-4	3.88-5	6.31-5
52	6.80-2	6.15-2	4.68-2	2.53-2	5.00-3	7.57-4	5.49-4	5.64-4
53	6.62-2	5.98-2	4.50-2	2.35-2	3.99-3	5.35-4	4.12-4	3.98-4
54	6.44-2	5.80-2	4.32-2	2.17-2	2.99-3	2.50-4	1.93-4	1.82-4
55	6.24-2	5.60-2	4.12-2	1.97-2	1.86-3	-2.52-4	-2.65-4	-2.74-4
56	6.06-2	5.42-2	3.94-2	1.79-2	9.24-4	-6.57-4	-6.67-4	-6.83-4
57	5.95-2	5.32-2	3.83-2	1.69-2	9.21-4	-2.15-4	-1.97-4	-2.02-4
58	5.86-2	5.23-2	3.74-2	1.61-2	1.12-3	3.40-4	3.59-4	3.55-4
59	5.75-2	5.12-2	3.63-2	1.52-2	1.17-3	6.46-4	6.54-4	6.36-4
60	5.62-2	5.00-2	3.51-2	1.41-2	1.14-3	8.12-4	8.39-4	8.47-4
61	5.41-2	4.79-2	3.29-2	1.22-2	1.84-4	-2.76-5	-1.67-5	-5.48-6
62	5.20-2	4.58-2	3.07-2	1.02-2	-8.06-4	-9.47-4	-9.42-4	-9.34-4
63	5.06-2	4.43-2	2.93-2	9.03-3	-9.93-4	-1.07-3	-1.04-3	-1.00-3
64	4.94-2	4.32-2	2.81-2	8.15-3	-9.41-4	-9.94-4	-9.94-4	-1.00-3
65	4.93-2	4.30-2	2.80-2	8.32-3	1.62-4	1.50-4	1.57-4	1.41-4
66	4.91-2	4.28-2	2.78-2	8.55-3	1.28-3	1.31-3	1.33-3	1.31-3
67	4.78-2	4.16-2	2.65-2	7.61-3	1.14-3	1.17-3	1.16-3	1.10-3
68	4.62-2	4.00-2	2.49-2	6.43-3	7.10-4	7.75-4	7.86-4	7.68-4
69	4.38-2	3.76-2	2.25-2	4.42-3	-6.25-4	-5.63-4	-5.53-4	-5.53-4
70	4.15-2	3.53-2	2.02-2	2.54-3	-1.91-3	-1.86-3	-1.88-3	-1.89-3
71	4.08-2	3.46-2	1.96-2	2.38-3	-1.46-3	-1.39-3	-1.37-3	-1.34-3
72	4.05-2	3.42-2	1.93-2	2.59-3	-7.10-4	-6.64-4	-6.68-4	-6.74-4
73	4.07-2	3.45-2	1.96-2	3.50-3	7.17-4	7.60-4	7.58-4	7.23-4
74	4.08-2	3.46-2	1.99-2	4.30-3	2.02-3	2.07-3	2.10-3	2.09-3
75	3.92-2	3.30-2	1.83-2	3.23-3	1.33-3	1.34-3	1.33-3	1.28-3
76	3.73-2	3.10-2	1.64-2	1.90-3	3.75-4	3.79-4	3.86-4	3.82-4
77	3.51-2	2.88-2	1.43-2	3.52-4	-8.63-4	-8.65-4	-8.62-4	-8.24-4
78	3.32-2	2.69-2	1.25-2	-9.11-4	-1.89-3	-1.92-3	-1.96-3	-1.94-3
79	3.31-2	2.68-2	1.25-2	-2.00-4	-8.99-4	-9.17-4	-9.28-4	-8.80-4

Appendix D  
Unperturbed Stratospheric Aerosol Model

Table D1. Optical Parameters

Wavelength ( $\mu\text{m}$ )	Extinction Cross Section ( $\text{m}^2$ )	Asymmetry Factor	Single Scattering Albedo	180 Degree Backscatter ( $\text{m}^2/\text{sr}$ )	Refractive Indices	
0.40	1.52-13	0.739	1.000	2.67-15	1.44	-1.00-8
0.44	1.41-13	0.736	1.000	2.38-15	1.44	-1.00-8
0.55	1.10-13	0.726	1.000	1.57-15	1.43	-1.00-8
0.75	6.89-14	0.673	1.000	1.11-15	1.43	-7.36-8
1.04	3.32-14	0.598	1.000	6.12-16	1.42	-1.37-6
1.24	2.15-14	0.537	1.000	5.02-16	1.41	-7.88-6
1.65	9.04-15	0.415	0.994	3.30-16	1.40	-3.15-4
2.20	3.32-15	0.279	0.947	1.79-16	1.37	-1.69-3

Table D2. Phase Functions

Scatter Angle (deg)	Wavelength ( $\mu\text{m}$ )							
	0.40	0.44	0.55	0.75	1.04	1.24	1.65	2.20
0	1.44 0	1.34 0	1.08 0	8.53-1	5.17-1	4.24-1	3.05-1	2.24-1
1	1.44 0	1.34 0	1.08 0	8.51-1	5.17-1	4.23-1	3.04-1	2.24-1
2	1.43 0	1.33 0	1.07 0	8.48-1	5.17-1	4.23-1	3.04-1	2.24-1
4	1.38 0	1.29 0	1.05 0	8.34-1	5.16-1	4.20-1	3.03-1	2.23-1
6	1.32 0	1.24 0	1.02 0	8.12-1	5.16-1	4.16-1	3.01-1	2.22-1
8	1.23 0	1.16 0	9.74-1	7.82-1	5.16-1	4.10-1	2.98-1	2.20-1
10	1.13 0	1.08 0	9.21-1	7.46-1	5.15-1	4.03-1	2.94-1	2.18-1
15	8.72-1	8.44-1	7.67-1	6.39-1	5.10-1	3.78-1	2.82-1	2.11-1
20	6.33-1	6.26-1	6.05-1	5.23-1	5.01-1	3.47-1	2.65-1	2.02-1
40	1.56-1	1.63-1	1.81-1	1.93-1	3.64-1	2.03-1	1.80-1	1.51-1
60	4.74-2	4.95-2	5.52-2	6.96-2	3.04-1	9.83-2	1.03-1	9.78-2
80	1.93-2	2.00-2	2.16-2	2.89-2	2.65-1	4.63-2	5.63-2	6.22-2
100	1.08-2	1.10-2	1.16-2	1.53-2	2.29-1	2.57-2	3.60-2	4.68-2
120	8.70-3	8.74-3	8.86-3	1.14-2	1.73-1	1.96-2	3.08-2	4.51-2
140	1.09-2	1.05-2	9.59-3	1.17-2	5.91-2	1.96-2	3.23-2	4.98-2
150	1.34-2	1.26-2	1.05-2	1.26-2	1.49-2	2.07-2	3.39-2	5.25-2
160	1.43-2	1.35-2	1.11-2	1.35-2	1.48-2	2.20-2	3.53-2	5.48-2
170	1.42-2	1.38-2	1.27-2	1.49-2	1.59-2	2.30-2	3.64-2	5.63-2
175	1.62-2	1.56-2	1.38-2	1.57-2	1.73-2	2.33-2	3.67-2	5.67-2
180	1.76-2	1.67-2	1.43-2	1.60-2	1.81-2	2.34-2	3.68-2	5.68-2

Table D3. Legendre Coefficients of Phase Functions

Index	Wavelength ( $\mu\text{m}$ )							
	0.40	0.44	0.55	0.75	1.04	1.24	1.65	2.20
0	1.00 0	1.00 0	1.00 0	1.00 0	1.00 0	1.00 0	1.00 0	1.00 0
1	2.22 0	2.21 0	2.18 0	2.02 0	1.79 0	1.61 0	1.24 0	8.38-1
2	2.79 0	2.73 0	2.57 0	2.20 0	1.67 0	1.39 0	9.99-1	7.18-1
3	2.64 0	2.54 0	2.27 0	1.77 0	1.03 0	7.46-1	3.99-1	2.04-1
4	2.33 0	2.19 0	1.81 0	1.31 0	5.61-1	3.53-1	1.35-1	4.39-2
5	1.89 0	1.73 0	1.31 0	8.88-1	2.56-1	1.38-1	3.70-2	7.75-3
6	1.46 0	1.31 0	8.97-1	5.86-1	1.14-1	5.35-2	9.64-3	1.18-3
7	1.11 0	9.68-1	5.85-1	3.71-1	4.43-2	1.81-2	2.21-3	1.47-4
8	8.02-1	6.87-1	3.73-1	2.33-1	1.85-2	6.53-3	6.02-4	5.31-5
9	5.81-1	4.86-1	2.25-1	1.39-1	6.88-3	2.06-3	1.87-4	2.66-5
10	4.09-1	3.37-1	1.39-1	8.56-2	3.22-3	8.18-4	9.58-5	8.72-5
11	2.82-1	2.28-1	7.78-2	4.76-2	9.63-4	2.47-4	-4.99-6	-6.53-6
12	2.00-1	1.60-1	4.89-2	2.98-2	-1.23-4	-9.68-6	-9.58-5	-8.49-5
13	1.29-1	1.01-1	2.48-2	1.50-2	-5.35-4	-5.91-5	-8.25-5	-4.70-5
14	9.50-2	7.40-2	1.64-2	9.96-3	-4.59-4	-7.87-5	-4.72-5	-7.07-5
15	5.59-2	4.30-2	7.42-3	4.50-3	2.48-4	2.12-5	7.00-5	2.92-5
16	4.43-2	3.39-2	5.48-3	3.38-3	9.49-4	1.25-4	1.59-4	1.55-4
17	2.32-2	1.76-2	2.15-3	1.36-3	7.43-4	1.05-4	7.51-5	6.36-5
18	2.03-2	1.53-2	1.72-3	1.07-3	1.63-4	3.58-5	-6.48-6	1.46-5
19	9.28-3	6.90-3	4.79-4	2.57-4	-7.04-4	-8.57-5	-1.20-4	-8.29-5
20	9.11-3	6.78-3	5.14-4	2.37-4	-1.28-3	-1.85-4	-2.17-4	-2.37-4
21	3.68-3	2.67-3	7.15-5	2.11-5	-3.94-4	-6.91-5	-5.57-5	-6.26-5
22	4.18-3	3.10-3	2.69-4	1.88-4	8.77-4	1.01-4	1.18-4	1.01-4
23	1.50-3	1.08-3	8.62-5	1.86-4	1.62-3	2.03-4	1.96-4	1.46-4
24	1.88-3	1.39-3	1.40-4	1.65-4	1.68-3	2.38-4	2.65-4	2.98-4
25	4.04-4	2.62-4	-8.33-5	-2.40-5	-2.44-4	-1.24-5	-9.76-6	2.33-5
26	5.12-4	3.06-4	-2.24-4	-2.72-4	-2.45-3	-3.08-4	-3.22-4	-2.77-4
27	-8.37-5	-1.34-4	-2.50-4	-3.05-4	-2.87-3	-3.56-4	-3.17-4	-2.07-4
28	1.07-4	2.10-5	-1.69-4	-2.25-4	-2.20-3	-3.10-4	-3.40-4	-3.53-4
29	1.58-4	1.23-4	8.94-5	8.13-5	8.38-4	7.38-5	5.44-5	2.30-5
30	3.73-4	3.48-4	3.28-4	3.96-4	3.86-3	4.89-4	5.30-4	5.16-4
31	3.15-4	3.00-4	3.00-4	3.66-4	3.66-3	4.56-4	4.22-4	2.82-4
32	1.05-4	1.17-4	1.35-4	1.62-4	1.91-3	2.53-4	2.82-4	2.68-4
33	-2.05-4	-1.93-4	-2.26-4	-2.67-4	-2.13-3	-2.62-4	-2.18-4	-1.57-4
34	-5.13-4	-4.85-4	-5.22-4	-6.41-4	-5.74-3	-7.38-4	-7.53-4	-7.33-4
35	-3.88-4	-3.51-4	-4.16-4	-5.15-4	-4.60-3	-5.69-4	-4.98-4	-3.41-4
36	-1.21-4	-8.09-5	-1.38-4	-1.94-4	-1.64-3	-2.35-4	-2.63-4	-2.57-4
37	2.81-4	3.34-4	3.01-4	3.20-4	3.13-3	3.64-4	2.98-4	2.15-4
38	6.24-4	6.70-4	6.34-4	7.30-4	6.96-3	8.90-4	9.07-4	9.06-4
39	4.79-4	5.12-4	4.62-4	5.22-4	4.83-3	5.74-4	4.87-4	3.38-4
40	1.90-4	2.07-4	1.14-4	1.22-4	8.92-4	1.07-4	1.07-4	9.92-5
41	-1.64-4	-1.67-4	-2.97-4	-3.61-4	-3.77-3	-4.55-4	-3.81-4	-2.72-4
42	-4.28-4	-4.30-4	-5.58-4	-6.81-4	-6.93-3	-8.97-4	-9.19-4	-9.16-4
43	-1.76-4	-1.70-4	-2.69-4	-3.49-4	-3.66-3	-4.43-4	-3.80-4	-2.62-4
44	1.98-4	2.18-4	1.73-4	1.58-4	1.20-3	1.52-4	1.59-4	1.62-4
45	5.13-4	5.40-4	5.35-4	5.71-4	5.07-3	6.07-4	5.17-4	3.71-4
46	7.18-4	7.29-4	7.17-4	7.85-4	7.08-3	8.94-4	9.20-4	9.15-4
47	4.37-4	4.20-4	3.78-4	3.75-4	2.96-3	3.25-4	2.74-4	1.86-4
48	8.86-5	4.37-5	-4.43-5	-1.30-4	-1.97-3	-3.02-4	-3.35-4	-3.62-4
49	-8.53-5	-1.50-4	-2.47-4	-3.69-4	-4.12-3	-5.37-4	-4.69-4	-3.51-4
50	-1.32-4	-1.88-4	-2.46-4	-3.75-4	-4.02-3	-5.44-4	-5.84-4	-6.09-4

Table D3. Concluded

Index	Wavelength ( $\mu\text{m}$ )							
	0.40	0.44	0.55	0.75	1.04	1.24	1.65	2.20
51	1.44-4	1.07-4	1.11-4	5.79-5	4.79-4	6.08-5	4.68-5	1.75-5
52	4.12-4	3.96-4	4.67-4	4.96-4	4.89-3	6.60-4	6.88-4	6.93-4
53	3.29-4	3.24-4	4.13-4	4.48-4	4.29-3	5.48-4	4.67-4	3.27-4
54	1.30-4	1.09-4	1.81-4	1.92-4	1.57-3	2.27-4	2.30-4	2.41-4
55	-1.94-4	-2.26-4	-1.89-4	-2.40-4	-2.97-3	-3.60-4	-3.27-4	-2.28-4
56	-4.13-4	-4.56-4	-4.26-4	-5.33-4	-6.10-3	-8.11-4	-8.84-4	-9.01-4
57	-1.57-4	-1.93-4	-1.21-4	-1.76-4	-2.47-3	-3.22-4	-2.99-4	-2.07-4
58	1.98-4	1.87-4	3.23-4	3.44-4	2.94-3	3.66-4	3.52-4	3.41-4
59	3.78-4	3.83-4	5.77-4	6.52-4	6.47-3	7.90-4	6.86-4	4.97-4
60	3.69-4	3.82-4	5.69-4	6.73-4	7.23-3	9.72-4	1.05-3	1.08-3
61	-2.04-4	-2.09-4	-8.88-5	-8.26-5	-4.49-6	3.09-5	6.57-5	5.91-5
62	-8.20-4	-8.41-4	-8.07-4	-9.19-4	-8.33-3	-1.04-3	-1.01-3	-9.87-4
63	-9.10-4	-9.41-4	-9.77-4	-1.10-3	-1.05-2	-1.25-3	-1.05-3	-7.47-4
64	-7.21-4	-7.37-4	-7.56-4	-8.70-4	-8.67-3	-1.12-3	-1.17-3	-1.19-3
65	8.53-5	1.09-4	1.50-4	1.96-4	1.61-3	1.90-4	1.52-4	9.43-5
66	8.66-4	9.15-4	1.02-3	1.22-3	1.18-2	1.52-3	1.55-3	1.53-3
67	8.17-4	8.84-4	1.00-3	1.20-3	1.18-2	1.44-3	1.23-3	8.72-4
68	4.22-4	4.61-4	5.10-4	6.37-4	6.75-3	9.15-4	9.66-4	1.00-3
69	-5.18-4	-5.17-4	-5.91-4	-6.57-4	-5.70-3	-6.39-4	-5.43-4	-3.62-4
70	-1.35-3	-1.38-3	-1.54-3	-1.79-3	-1.69-2	-2.11-3	-2.16-3	-2.11-3
71	-1.07-3	-1.10-3	-1.28-3	-1.49-3	-1.41-2	-1.66-3	-1.43-3	-9.95-4
72	-4.07-4	-4.12-4	-5.16-4	-6.25-4	-6.11-3	-7.46-4	-8.01-4	-7.90-4
73	6.81-4	7.11-4	7.15-4	7.98-4	7.45-3	9.22-4	7.57-4	5.31-4
74	1.58-3	1.62-3	1.67-3	1.94-3	1.83-2	2.37-3	2.40-3	2.37-3
75	1.21-3	1.23-3	1.25-3	1.43-3	1.31-2	1.58-3	1.33-3	9.29-4
76	4.86-4	4.53-4	3.47-4	3.95-4	2.85-3	3.68-4	3.69-4	3.45-4
77	-4.41-4	-5.33-4	-7.61-4	-8.87-4	-9.57-3	-1.15-3	-9.67-4	-6.90-4
78	-1.11-3	-1.22-3	-1.49-3	-1.76-3	-1.81-2	-2.32-3	-2.35-3	-2.35-3
79	-5.12-4	-6.20-4	-8.34-4	-9.92-4	-1.01-2	-1.22-3	-1.00-3	-7.07-4

Appendix E  
Upper Atmospheric Aerosol Model

Table E1. Optical Parameters

Wavelength ( $\mu\text{m}$ )	Extinction Cross Section ( $\text{m}^2$ )	Asymmetry Factor	Single Scattering Albedo	180 Degree Backscatter ( $\text{m}^2/\text{sr}$ )	Refractive Indices
0.40	8.71-14	0.793	0.998	2.62-15	1.34 -1.09-4
0.44	8.80-14	0.767	0.998	2.59-15	1.38 -1.46-4
0.55	8.34-14	0.764	0.995	2.42-15	1.38 -2.87-4
0.75	7.37-14	0.770	0.991	1.28-15	1.37 -7.40-4
1.04	6.22-14	0.770	0.976	1.03-15	1.36 -2.04-3
1.24	5.47-14	0.775	0.963	7.57-16	1.35 -3.56-3
1.65	4.22-14	0.783	0.917	4.09-16	1.33 -8.98-3
2.20	3.02-14	0.795	0.805	1.80-16	1.30 -2.36-2

Table E2. Phase Functions

Scatter Angle (deg)	Wavelength ( $\mu\text{m}$ )							
	0.40	0.44	0.55	0.75	1.04	1.24	1.65	2.20
0	1.32 1	1.10 1	7.85 0	5.21 0	3.68 0	3.19 0	2.68 0	2.36 0
1	1.15 1	9.77 0	7.29 0	5.01 0	3.60 0	3.15 0	2.66 0	2.35 0
2	8.20 0	7.27 0	5.97 0	4.49 0	3.40 0	3.02 0	2.59 0	2.31 0
4	4.23 0	3.87 0	3.54 0	3.16 0	2.77 0	2.59 0	2.35 0	2.17 0
6	2.66 0	2.47 0	2.36 0	2.23 0	2.14 0	2.09 0	2.03 0	1.95 0
8	1.88 0	1.75 0	1.72 0	1.71 0	1.68 0	1.67 0	1.69 0	1.70 0
10	1.41 0	1.33 0	1.33 0	1.36 0	1.36 0	1.37 0	1.40 0	1.46 0
15	8.12-1	7.74-1	7.96-1	8.41-1	8.61-1	8.79-1	9.06-1	9.48-1
20	5.20-1	5.05-1	5.27-1	5.53-1	5.76-1	5.90-1	6.07-1	6.29-1
40	1.18-1	1.27-1	1.31-1	1.34-1	1.38-1	1.39-1	1.41-1	1.39-1
60	3.41-2	3.98-2	4.11-2	4.10-2	4.18-2	4.16-2	4.13-2	4.05-2
80	1.29-2	1.56-2	1.61-2	1.63-2	1.65-2	1.62-2	1.59-2	1.55-2
100	6.93-3	8.64-3	8.73-3	8.53-3	8.82-3	8.78-3	8.53-3	8.13-3
120	6.36-3	6.94-3	7.27-3	6.85-3	7.18-3	7.03-3	6.71-3	6.16-3
140	1.12-2	1.09-2	1.09-2	9.68-3	9.51-3	8.89-3	7.73-3	6.29-3
150	1.46-2	1.72-2	1.54-2	1.41-2	1.23-2	1.11-2	8.88-3	6.74-3
160	1.51-2	2.07-2	2.04-2	1.72-2	1.47-2	1.29-2	1.01-2	7.30-3
170	1.89-2	2.28-2	2.14-2	1.80-2	1.47-2	1.31-2	1.01-2	7.28-3
175	1.77-2	2.14-2	2.09-2	1.41-2	1.31-2	1.15-2	9.23-3	7.17-3
180	3.02-2	2.95-2	2.92-2	1.75-2	1.70-2	1.44-2	1.06-2	7.40-3

Table E3. Legendre Coefficients of Phase Functions

Index	Wavelength ( $\mu\text{m}$ )							
	0.40	0.44	0.55	0.75	1.04	1.24	1.65	2.20
0	1.00 0	1.00 0	1.00 0	1.00 0	1.00 0	1.00 0	1.00 0	1.00 0
1	2.38 0	2.30 0	2.29 0	2.31 0	2.31 0	2.32 0	2.35 0	2.38 0
2	3.34 0	3.17 0	3.12 0	3.09 0	3.05 0	3.05 0	3.06 0	3.09 0
3	3.59 0	3.31 0	3.22 0	3.17 0	3.11 0	3.11 0	3.12 0	3.18 0
4	3.75 0	3.44 0	3.29 0	3.16 0	3.02 0	2.99 0	2.97 0	3.00 0
5	3.72 0	3.35 0	3.15 0	2.97 0	2.77 0	2.72 0	2.68 0	2.69 0
6	3.66 0	3.30 0	3.04 0	2.77 0	2.53 0	2.44 0	2.37 0	2.35 0
7	3.60 0	3.24 0	2.93 0	2.60 0	2.30 0	2.19 0	2.08 0	2.02 0
8	3.53 0	3.15 0	2.80 0	2.41 0	2.08 0	1.95 0	1.81 0	1.71 0
9	3.47 0	3.12 0	2.72 0	2.28 0	1.91 0	1.76 0	1.59 0	1.45 0
10	3.42 0	3.05 0	2.61 0	2.13 0	1.73 0	1.58 0	1.39 0	1.22 0
11	3.35 0	3.00 0	2.54 0	2.02 0	1.60 0	1.43 0	1.22 0	1.03 0
12	3.31 0	2.95 0	2.47 0	1.91 0	1.48 0	1.30 0	1.07 0	8.59-1
13	3.25 0	2.89 0	2.40 0	1.81 0	1.38 0	1.19 0	9.48-1	7.19-1
14	3.21 0	2.84 0	2.32 0	1.71 0	1.27 0	1.08 0	8.33-1	5.98-1
15	3.15 0	2.78 0	2.25 0	1.63 0	1.18 0	9.93-1	7.38-1	4.97-1
16	3.08 0	2.72 0	2.18 0	1.54 0	1.09 0	9.06-1	6.48-1	4.10-1
17	3.04 0	2.67 0	2.12 0	1.47 0	1.02 0	8.34-1	5.73-1	3.37-1
18	2.97 0	2.60 0	2.05 0	1.39 0	9.48-1	7.60-1	5.02-1	2.74-1
19	2.92 0	2.55 0	1.99 0	1.34 0	8.83-1	6.97-1	4.42-1	2.21-1
20	2.86 0	2.48 0	1.94 0	1.27 0	8.18-1	6.37-1	3.85-1	1.77-1
21	2.79 0	2.43 0	1.86 0	1.22 0	7.58-1	5.80-1	3.35-1	1.40-1
22	2.74 0	2.37 0	1.81 0	1.16 0	7.06-1	5.30-1	2.90-1	1.10-1
23	2.67 0	2.31 0	1.73 0	1.11 0	6.52-1	4.80-1	2.48-1	8.30-2
24	2.62 0	2.26 0	1.68 0	1.06 0	6.08-1	4.38-1	2.12-1	6.19-2
25	2.56 0	2.20 0	1.62 0	1.01 0	5.58-1	3.94-1	1.77-1	4.22-2
26	2.51 0	2.15 0	1.57 0	9.68-1	5.20-1	3.58-1	1.49-1	2.83-2
27	2.45 0	2.09 0	1.51 0	9.24-1	4.76-1	3.19-1	1.21-1	1.55-2
28	2.40 0	2.04 0	1.47 0	8.86-1	4.43-1	2.89-1	9.95-2	8.82-3
29	2.34 0	1.97 0	1.41 0	8.44-1	4.04-1	2.55-1	7.66-2	3.12-3
30	2.29 0	1.93 0	1.37 0	8.10-1	3.76-1	2.30-1	6.14-2	1.58-3
31	2.22 0	1.87 0	1.32 0	7.68-1	3.40-1	2.00-1	4.41-2	3.35-4
32	2.18 0	1.83 0	1.28 0	7.35-1	3.16-1	1.79-1	3.44-2	2.62-4
33	2.12 0	1.78 0	1.23 0	6.92-1	2.84-1	1.53-1	2.26-2	1.36-4
34	2.08 0	1.73 0	1.19 0	6.60-1	2.63-1	1.36-1	1.76-2	-1.37-4
35	2.02 0	1.68 0	1.15 0	6.18-1	2.35-1	1.15-1	1.05-2	-1.36-4
36	1.98 0	1.64 0	1.11 0	5.89-1	2.17-1	1.01-1	9.09-3	-9.64-5
37	1.92 0	1.59 0	1.07 0	5.50-1	1.94-1	8.37-2	4.85-3	9.42-5
38	1.88 0	1.55 0	1.03 0	5.24-1	1.78-1	7.35-2	4.79-3	3.86-4
39	1.83 0	1.50 0	9.83-1	4.88-1	1.58-1	5.96-2	1.73-3	3.37-4
40	1.79 0	1.46 0	9.50-1	4.63-1	1.44-1	5.16-2	1.61-3	1.75-4
41	1.74 0	1.42 0	9.03-1	4.31-1	1.26-1	4.11-2	-1.58-4	-5.94-5
42	1.70 0	1.38 0	8.75-1	4.06-1	1.14-1	3.53-2	-1.24-4	-2.96-4
43	1.65 0	1.35 0	8.33-1	3.78-1	9.98-2	2.75-2	-2.60-4	-1.53-4
44	1.61 0	1.31 0	8.07-1	3.54-1	8.98-2	2.38-2	1.94-4	1.17-4
45	1.56 0	1.27 0	7.71-1	3.30-1	7.77-2	1.74-2	5.49-4	3.58-4
46	1.52 0	1.23 0	7.44-1	3.09-1	6.90-2	1.45-2	6.70-4	5.44-4
47	1.48 0	1.19 0	7.13-1	2.87-1	5.81-2	9.01-3	4.52-4	3.67-4
48	1.44 0	1.16 0	6.84-1	2.68-1	5.02-2	6.78-3	8.88-5	1.12-4
49	1.40 0	1.12 0	6.57-1	2.48-1	4.08-2	3.19-3	-1.25-4	-5.55-6
50	1.36 0	1.08 0	6.29-1	2.31-1	3.44-2	2.45-3	-1.27-4	-2.35-5



Table E3. Continued

Index	Wavelength ( $\mu\text{m}$ )							
	0.40	0.44	0.55	0.75	1.04	1.24	1.65	2.20
51	1.32 0	1.05 0	6.03-1	2.13-1	2.71-2	9.49-4	9.99-5	2.09-4
52	1.29 0	1.01 0	5.79-1	1.98-1	2.27-2	1.26-3	3.75-4	4.47-4
53	1.25 0	9.81-1	5.53-1	1.81-1	1.70-2	5.35-4	3.46-4	4.04-4
54	1.22 0	9.53-1	5.31-1	1.67-1	1.39-2	5.51-4	1.55-4	2.48-4
55	1.18 0	9.19-1	5.07-1	1.51-1	9.64-3	1.47-5	-1.05-4	-5.04-6
56	1.15 0	8.94-1	4.87-1	1.38-1	7.92-3	-1.08-4	-3.04-4	-1.67-4
57	1.12 0	8.61-1	4.65-1	1.25-1	5.22-3	-7.26-5	-8.90-5	4.63-5
58	1.09 0	8.39-1	4.46-1	1.15-1	4.91-3	2.58-4	2.39-4	3.43-4
59	1.06 0	8.07-1	4.26-1	1.04-1	2.93-3	3.23-4	3.96-4	4.94-4
60	1.03 0	7.85-1	4.06-1	9.42-2	2.67-3	3.33-4	3.92-4	4.36-4
61	9.98-1	7.56-1	3.86-1	8.42-2	7.14-4	-1.53-4	-1.10-4	-7.98-5
62	9.68-1	7.31-1	3.67-1	7.57-2	9.91-5	-6.78-4	-6.50-4	-6.27-4
63	9.39-1	7.06-1	3.49-1	6.75-2	-7.04-4	-7.29-4	-7.43-4	-7.59-4
64	9.12-1	6.82-1	3.32-1	6.11-2	-5.06-4	-5.64-4	-5.70-4	-5.81-4
65	8.85-1	6.59-1	3.16-1	5.50-2	2.88-5	1.40-4	1.40-4	9.20-5
66	8.59-1	6.37-1	3.01-1	5.04-2	7.45-4	8.05-4	8.07-4	7.21-4
67	8.32-1	6.14-1	2.85-1	4.44-2	7.17-4	7.47-4	7.81-4	6.90-4
68	8.07-1	5.93-1	2.70-1	3.97-2	3.35-4	3.95-4	4.11-4	2.77-4
69	7.80-1	5.70-1	2.54-1	3.36-2	-5.35-4	-4.28-4	-4.25-4	-5.73-4
70	7.56-1	5.51-1	2.41-1	2.91-2	-1.31-3	-1.13-3	-1.14-3	-1.28-3
71	7.31-1	5.30-1	2.26-1	2.45-2	-1.14-3	-8.51-4	-9.01-4	-1.09-3
72	7.10-1	5.13-1	2.15-1	2.19-2	-5.49-4	-2.49-4	-2.95-4	-4.74-4
73	6.87-1	4.94-1	2.01-1	1.85-2	4.08-4	7.35-4	6.84-4	4.94-4
74	6.66-1	4.76-1	1.91-1	1.70-2	1.25-3	1.50-3	1.44-3	1.25-3
75	6.43-1	4.57-1	1.78-1	1.30-2	1.01-3	1.18-3	1.14-3	1.01-3
76	6.23-1	4.40-1	1.68-1	1.10-2	4.29-4	5.18-4	4.75-4	3.70-4
77	6.01-1	4.21-1	1.56-1	7.35-3	-3.17-4	-3.15-4	-3.63-4	-4.25-4
78	5.81-1	4.05-1	1.46-1	6.18-3	-8.65-4	-8.75-4	-9.13-4	-9.31-4
79	5.62-1	3.89-1	1.37-1	4.44-3	-3.14-4	-3.44-4	-4.07-4	-4.30-4
80	5.45-1	3.75-1	1.30-1	5.02-3	4.82-4	4.63-4	4.06-4	3.90-4
81	5.26-1	3.60-1	1.21-1	3.86-3	1.17-3	1.16-3	1.12-3	1.11-3
82	5.10-1	3.46-1	1.14-1	4.22-3	1.60-3	1.56-3	1.51-3	1.50-3
83	4.91-1	3.31-1	1.05-1	2.21-3	1.05-3	9.72-4	9.51-4	9.93-4
84	4.74-1	3.17-1	9.74-2	1.57-3	3.67-4	2.34-4	2.24-4	2.98-4
85	4.57-1	3.03-1	8.93-2	2.41-4	3.20-5	-1.70-4	-1.70-4	-6.95-5
86	4.41-1	2.90-1	8.30-2	3.35-4	-2.55-5	-2.38-4	-2.30-4	-1.04-4
87	4.26-1	2.77-1	7.64-2	4.02-4	5.51-4	3.15-4	3.20-4	4.49-4
88	4.11-1	2.66-1	7.13-2	1.16-3	1.11-3	9.02-4	8.86-4	9.95-4
89	3.96-1	2.53-1	6.46-2	8.81-4	9.95-4	8.19-4	8.00-4	9.17-4
90	3.81-1	2.42-1	5.94-2	6.29-4	6.08-4	4.66-4	4.34-4	5.35-4
91	3.66-1	2.29-1	5.28-2	-1.74-5	-2.35-5	-1.22-4	-1.62-4	-7.30-5
92	3.51-1	2.19-1	4.83-2	-4.56-4	-4.71-4	-5.44-4	-5.68-4	-4.73-4
93	3.38-1	2.08-1	4.32-2	-5.59-5	-4.96-5	-1.08-4	-1.27-4	-6.58-5
94	3.25-1	1.99-1	4.04-2	4.69-4	5.78-4	5.31-4	5.17-4	5.53-4
95	3.13-1	1.89-1	3.58-2	8.12-4	8.95-4	8.61-4	8.65-4	8.95-4
96	3.00-1	1.80-1	3.29-2	7.10-4	8.40-4	8.41-4	8.28-4	8.15-4
97	2.86-1	1.69-1	2.76-2	-2.33-4	-2.31-4	-1.75-4	-1.92-4	-2.07-4
98	2.73-1	1.60-1	2.41-2	-1.35-3	-1.39-3	-1.28-3	-1.29-3	-1.31-3
99	2.61-1	1.51-1	2.01-2	-1.53-3	-1.67-3	-1.50-3	-1.54-3	-1.61-3
100	2.50-1	1.43-1	1.83-2	-1.25-3	-1.41-3	-1.22-3	-1.23-3	-1.30-3

Table E3. Concluded

Index	Wavelength ( $\mu\text{m}$ )							
	0.40	0.44	0.55	0.75	1.04	1.24	1.65	2.20
101	2.40-1	1.36-1	1.63-2	2.99-5	-7.59-5	1.28-4	1.18-4	4.15-6
102	2.30-1	1.30-1	1.58-2	1.30-3	1.25-3	1.41-3	1.40-3	1.25-3
103	2.19-1	1.21-1	1.28-2	1.15-3	1.20-3	1.35-3	1.37-3	1.26-3
104	2.08-1	1.14-1	1.09-2	4.71-4	5.53-4	6.65-4	6.60-4	5.39-4
105	1.97-1	1.05-1	6.90-3	-1.15-3	-1.01-3	-9.17-4	-9.29-4	-1.02-3
106	1.86-1	9.76-2	4.64-3	-2.51-3	-2.40-3	-2.31-3	-2.30-3	-2.34-3
107	1.77-1	9.11-2	3.02-3	-2.09-3	-1.97-3	-1.90-3	-1.92-3	-2.01-3
108	1.69-1	8.66-2	3.60-3	-1.00-3	-8.89-4	-8.33-4	-8.23-4	-8.90-4
109	1.62-1	8.18-2	3.62-3	8.08-4	8.99-4	9.32-4	9.58-4	8.75-4
110	1.55-1	7.81-2	4.96-3	2.32-3	2.40-3	2.37-3	2.37-3	2.26-3
111	1.46-1	7.15-2	3.05-3	1.89-3	1.90-3	1.83-3	1.87-3	1.83-3
112	1.38-1	6.59-2	2.06-3	8.57-4	8.23-4	6.81-4	6.98-4	6.87-4
113	1.29-1	5.88-2	-3.73-4	-5.01-4	-5.81-4	-7.85-4	-7.83-4	-7.49-4
114	1.21-1	5.38-2	-1.25-3	-1.49-3	-1.58-3	-1.79-3	-1.78-3	-1.68-3
115	1.15-1	4.96-2	-1.07-3	-5.72-4	-6.14-4	-8.73-4	-8.91-4	-8.23-4

Appendix F  
Water-Soluble Aerosol Model

Table F1. Optical Parameters

Wavelength ( $\mu\text{m}$ )	Extinction Cross Section ( $\text{m}^2$ )	Asymmetry Factor	Single Scattering Albedo	180 Degree Backscatter ( $\text{m}^2/\text{sr}$ )	Refractive Indices	
0.40	7.80-16	0.642	0.966	2.46-17	1.53	-5.00-3
0.44	7.04-16	0.639	0.962	2.15-17	1.53	-5.45-3
0.55	5.48-16	0.630	0.958	1.56-17	1.53	-6.00-3
0.75	3.65-16	0.614	0.937	9.08-18	1.53	-8.69-3
1.04	2.26-16	0.600	0.876	4.77-18	1.52	-1.65-2
1.24	1.69-16	0.590	0.848	3.40-18	1.51	-1.93-2
1.65	9.84-17	0.574	0.809	1.95-18	1.49	-2.04-2
2.20	4.30-17	0.565	0.851	9.60-19	1.42	-9.60-3

Table F2. Phase Functions

Scatter Angle (deg)	Wavelength ( $\mu\text{m}$ )							
	0.40	0.44	0.55	0.75	1.04	1.24	1.65	2.20
0	1.46 0	1.35 0	1.21 0	9.63-1	8.50-1	7.90-1	7.22-1	7.15-1
1	1.43 0	1.33 0	1.19 0	9.56-1	8.47-1	7.88-1	7.20-1	7.13-1
2	1.36 0	1.27 0	1.16 0	9.39-1	8.38-1	7.81-1	7.16-1	7.09-1
4	1.20 0	1.14 0	1.05 0	8.82-1	8.05-1	7.56-1	6.98-1	6.94-1
6	1.06 0	1.01 0	9.51-1	8.18-1	7.59-1	7.20-1	6.71-1	6.69-1
8	9.36-1	9.01-1	8.56-1	7.56-1	7.10-1	6.78-1	6.38-1	6.39-1
10	8.29-1	8.05-1	7.71-1	6.98-1	6.60-1	6.34-1	6.01-1	6.04-1
15	6.23-1	6.16-1	5.97-1	5.69-1	5.43-1	5.28-1	5.08-1	5.10-1
20	4.79-1	4.78-1	4.68-1	4.61-1	4.42-1	4.34-1	4.22-1	4.23-1
40	1.76-1	1.77-1	1.79-1	1.83-1	1.85-1	1.85-1	1.85-1	1.83-1
60	6.92-2	7.04-2	7.26-2	7.55-2	7.84-2	7.97-2	8.10-2	7.96-2
80	3.16-2	3.21-2	3.34-2	3.52-2	3.71-2	3.80-2	3.93-2	3.87-2
100	1.80-2	1.83-2	1.91-2	2.04-2	2.16-2	2.24-2	2.36-2	2.38-2
120	1.38-2	1.41-2	1.47-2	1.59-2	1.70-2	1.79-2	1.92-2	2.02-2
140	1.51-2	1.53-2	1.58-2	1.67-2	1.76-2	1.83-2	1.99-2	2.16-2
150	1.75-2	1.76-2	1.77-2	1.82-2	1.87-2	1.95-2	2.11-2	2.31-2
160	2.01-2	1.98-2	1.99-2	2.01-2	1.97-2	2.05-2	2.22-2	2.45-2
170	2.41-2	2.36-2	2.30-2	2.23-2	2.13-2	2.17-2	2.32-2	2.54-2
175	2.91-2	2.84-2	2.70-2	2.49-2	2.31-2	2.30-2	2.41-2	2.59-2
180	3.27-2	3.17-2	2.96-2	2.65-2	2.41-2	2.37-2	2.45-2	2.62-2

Table F3. Legendre Coefficients of Phase Functions

Index	Wavelength ( $\mu\text{m}$ )							
	0.40	0.44	0.55	0.75	1.04	1.24	1.65	2.20
0	1.00 0	1.00 0	1.00 0	1.00 0	1.00 0	1.00 0	1.00 0	1.00 0
1	1.93 0	1.92 0	1.89 0	1.84 0	1.80 0	1.77 0	1.72 0	1.70 0
2	2.18 0	2.14 0	2.08 0	1.97 0	1.88 0	1.83 0	1.76 0	1.77 0
3	1.82 0	1.77 0	1.69 0	1.54 0	1.43 0	1.37 0	1.29 0	1.30 0
4	1.53 0	1.47 0	1.37 0	1.19 0	1.07 0	1.01 0	9.25-1	9.37-1
5	1.20 0	1.14 0	1.05 0	8.66-1	7.69-1	7.11-1	6.38-1	6.48-1
6	9.95-1	9.28-1	8.37-1	6.54-1	5.65-1	5.12-1	4.46-1	4.52-1
7	8.09-1	7.43-1	6.60-1	4.87-1	4.17-1	3.70-1	3.15-1	3.17-1
8	6.93-1	6.26-1	5.49-1	3.79-1	3.20-1	2.77-1	2.28-1	2.24-1
9	5.82-1	5.17-1	4.49-1	2.90-1	2.44-1	2.07-1	1.67-1	1.62-1
10	5.17-1	4.55-1	3.91-1	2.34-1	1.97-1	1.63-1	1.27-1	1.18-1
11	4.41-1	3.83-1	3.27-1	1.82-1	1.54-1	1.26-1	9.53-2	8.74-2
12	4.04-1	3.49-1	2.96-1	1.53-1	1.31-1	1.05-1	7.56-2	6.57-2
13	3.46-1	2.95-1	2.51-1	1.24-1	1.03-1	8.14-2	5.75-2	4.95-2
14	3.23-1	2.75-1	2.34-1	1.19-1	8.99-2	6.95-2	4.73-2	3.83-2
15	2.78-1	2.33-1	1.99-1	1.06-1	7.10-2	5.46-2	3.62-2	2.89-2
16	2.60-1	2.19-1	1.87-1	1.04-1	6.35-2	4.83-2	3.06-2	2.29-2
17	2.23-1	1.87-1	1.59-1	8.68-2	5.10-2	3.80-2	2.33-2	1.69-2
18	2.10-1	1.76-1	1.45-1	8.57-2	4.62-2	3.36-2	1.98-2	1.35-2
19	1.81-1	1.52-1	1.17-1	7.12-2	3.78-2	2.67-2	1.49-2	9.45-3
20	1.69-1	1.43-1	1.04-1	6.76-2	3.44-2	2.37-2	1.26-2	7.51-3
21	1.46-1	1.27-1	8.61-2	5.86-2	2.85-2	1.90-2	9.51-3	5.03-3
22	1.35-1	1.22-1	8.20-2	5.13-2	2.58-2	1.68-2	8.17-3	4.17-3
23	1.18-1	1.11-1	7.41-2	4.28-2	2.17-2	1.37-2	6.14-3	2.56-3
24	1.09-1	1.06-1	7.15-2	3.66-2	1.94-2	1.20-2	5.17-3	2.16-3
25	9.90-2	9.44-2	6.49-2	3.06-2	1.62-2	9.60-3	3.60-3	9.46-4
26	9.40-2	8.69-2	5.92-2	2.70-2	1.41-2	8.01-3	2.68-3	5.99-4
27	8.76-2	7.44-2	5.29-2	2.38-2	1.20-2	6.44-3	1.80-3	4.93-5
28	8.45-2	6.74-2	4.80-2	2.21-2	1.07-2	5.45-3	1.38-3	1.09-4
29	7.78-2	5.78-2	4.49-2	2.09-2	9.43-3	4.67-3	1.15-3	1.70-4
30	7.48-2	5.35-2	4.26-2	2.04-2	8.61-3	4.24-3	1.23-3	5.83-4
31	6.71-2	4.87-2	4.06-2	1.92-2	7.31-3	3.37-3	8.48-4	3.85-4
32	6.38-2	4.67-2	3.80-2	1.83-2	6.21-3	2.63-3	5.28-4	2.44-4
33	5.73-2	4.55-2	3.42-2	1.65-2	4.86-3	1.62-3	-8.75-5	-2.37-4
34	5.40-2	4.44-2	3.07-2	1.52-2	3.77-3	8.17-4	-5.79-4	-6.59-4
35	5.03-2	4.43-2	2.66-2	1.39-2	3.25-3	6.07-4	-4.67-4	-4.72-4
36	4.73-2	4.31-2	2.48-2	1.31-2	3.02-3	6.36-4	-2.06-4	-2.05-4
37	4.54-2	4.18-2	2.29-2	1.23-2	2.97-3	8.98-4	2.99-4	3.04-4
38	4.26-2	3.93-2	2.26-2	1.17-2	3.00-3	1.20-3	7.80-4	7.85-4
39	4.06-2	3.57-2	2.16-2	1.02-2	2.28-3	7.50-4	4.95-4	4.79-4
40	3.81-2	3.20-2	2.04-2	8.91-3	1.58-3	2.78-4	1.22-4	1.13-4
41	3.65-2	2.80-2	1.89-2	7.43-3	8.01-4	-2.90-4	-3.45-4	-3.45-4
42	3.49-2	2.52-2	1.69-2	6.29-3	2.24-4	-7.05-4	-7.47-4	-7.47-4
43	3.40-2	2.32-2	1.55-2	5.88-3	4.03-4	-3.40-4	-3.42-4	-3.25-4
44	3.33-2	2.28-2	1.46-2	5.82-3	7.68-4	1.65-4	1.56-4	1.73-4
45	3.17-2	2.21-2	1.36-2	5.64-3	9.87-4	5.46-4	5.26-4	5.36-4
46	3.02-2	2.22-2	1.33-2	5.56-3	1.14-3	8.23-4	8.05-4	8.33-4
47	2.73-2	2.12-2	1.21-2	4.68-3	5.43-4	3.45-4	3.08-4	3.27-4
48	2.51-2	2.02-2	1.12-2	3.95-3	-4.17-5	-1.74-4	-2.16-4	-1.97-4
49	2.26-2	1.91-2	1.02-2	3.43-3	-2.98-4	-3.74-4	-3.87-4	-3.72-4
50	2.13-2	1.79-2	9.49-3	3.22-3	-3.53-4	-4.21-4	-4.19-4	-4.32-4

Table F3. Concluded

Index	Wavelength ( $\mu\text{m}$ )							
	0.40	0.44	0.55	0.75	1.04	1.24	1.65	2.20
51	2.02-2	1.70-2	9.08-3	3.48-3	1.15-4	7.11-5	1.00-4	7.00-5
52	1.97-2	1.62-2	8.87-3	3.64-3	6.04-4	5.63-4	6.15-4	5.73-4
53	1.87-2	1.49-2	8.16-3	3.23-3	4.91-4	4.41-4	4.87-4	4.37-4
54	1.77-2	1.37-2	7.55-3	2.72-3	2.27-4	1.80-4	2.31-4	1.97-4
55	1.67-2	1.24-2	6.63-3	1.95-3	-2.51-4	-2.94-4	-2.64-4	-2.69-4
56	1.58-2	1.16-2	5.93-3	1.43-3	-6.33-4	-6.70-4	-6.72-4	-6.74-4
57	1.56-2	1.14-2	5.85-3	1.63-3	-2.25-4	-2.37-4	-2.39-4	-2.20-4
58	1.55-2	1.16-2	5.99-3	1.97-3	3.27-4	3.25-4	3.23-4	3.40-4
59	1.51-2	1.14-2	5.89-3	2.07-3	6.43-4	6.58-4	6.39-4	6.35-4
60	1.46-2	1.11-2	5.64-3	2.02-3	7.75-4	8.05-4	8.10-4	8.26-4
61	1.31-2	9.87-3	4.56-3	1.08-3	-3.60-5	-8.58-6	-1.46-5	-1.19-5
62	1.16-2	8.50-3	3.46-3	1.01-4	-9.33-4	-9.15-4	-9.30-4	-9.25-4
63	1.06-2	7.83-3	3.05-3	-1.75-4	-1.08-3	-1.06-3	-1.05-3	-1.02-3
64	1.02-2	7.42-3	2.99-3	-1.14-4	-9.64-4	-9.54-4	-9.68-4	-9.80-4
65	1.04-2	7.95-3	3.81-3	8.82-4	1.54-4	1.64-4	1.74-4	1.52-4
66	1.09-2	8.54-3	4.65-3	1.90-3	1.27-3	1.30-3	1.32-3	1.30-3
67	1.02-2	8.05-3	4.33-3	1.73-3	1.17-3	1.17-3	1.17-3	1.12-3
68	9.39-3	7.31-3	3.65-3	1.20-3	7.21-4	7.28-4	7.51-4	7.28-4
69	7.83-3	5.77-3	2.16-3	-1.72-4	-5.97-4	-6.05-4	-5.99-4	-6.01-4
70	6.41-3	4.41-3	8.00-4	-1.44-3	-1.84-3	-1.87-3	-1.90-3	-1.90-3
71	6.51-3	4.49-3	9.71-4	-1.12-3	-1.42-3	-1.43-3	-1.43-3	-1.39-3
72	7.00-3	5.01-3	1.60-3	-3.72-4	-6.33-4	-6.50-4	-6.79-4	-6.69-4
73	8.05-3	6.05-3	2.80-3	9.80-4	7.94-4	7.97-4	7.60-4	7.54-4
74	8.90-3	6.91-3	3.88-3	2.17-3	2.05-3	2.08-3	2.07-3	2.09-3
75	7.99-3	6.04-3	3.17-3	1.52-3	1.38-3	1.39-3	1.34-3	1.33-3
76	6.78-3	4.81-3	2.12-3	5.01-4	3.83-4	3.97-4	3.58-4	3.83-4
77	5.23-3	3.35-3	7.96-4	-7.62-4	-8.92-4	-8.82-4	-9.15-4	-8.63-4
78	4.06-3	2.23-3	-2.35-4	-1.75-3	-1.89-3	-1.91-3	-1.97-3	-1.95-3
79	4.53-3	2.85-3	4.92-4	-8.65-4	-9.62-4	-9.62-4	-9.71-4	-9.32-4

Appendix G  
Dust-Like Aerosol Model

Table G1. Optical Parameters

Wavelength ( $\mu\text{m}$ )	Extinction Cross Section ( $\text{m}^2$ )	Asymmetry Factor	Single Scattering Albedo	180 Degree Backscatter ( $\text{m}^2/\text{sr}$ )	Refractive Indices	
0.40	1.33-11	0.878	0.655	1.79-13	1.53	-8.00-3
0.44	1.34-11	0.872	0.665	1.94-13	1.53	-8.00-3
0.55	1.36-11	0.855	0.693	2.51-13	1.53	-8.00-3
0.75	1.39-11	0.830	0.731	3.38-13	1.53	-8.00-3
1.04	1.44-11	0.802	0.773	4.60-13	1.52	-8.00-3
1.24	1.46-11	0.799	0.797	3.39-13	1.48	-8.00-3
1.65	1.50-11	0.818	0.837	2.54-13	1.37	-8.00-3
2.20	1.44-11	0.888	0.864	8.97-14	1.23	-8.80-3

Table G2. Phase Functions

Scatter Angle (deg)	Wavelength ( $\mu\text{m}$ )							
	0.40	0.44	0.55	0.75	1.04	1.24	1.65	2.20
0	3.58 2	2.92 2	1.80 2	9.22 1	4.56 1	3.13 1	1.74 1	1.18 1
1	1.44 2	1.36 2	1.09 2	6.98 1	3.94 1	2.82 1	1.64 1	1.14 1
2	3.38 1	3.37 1	3.38 1	3.28 1	2.58 1	2.09 1	1.38 1	1.04 1
4	6.09 0	6.40 0	6.95 0	7.61 0	7.58 0	7.68 0	7.38 0	7.26 0
6	2.08 0	2.22 0	2.53 0	2.91 0	3.23 0	3.32 0	3.51 0	4.38 0
8	9.78-1	1.04 0	1.21 0	1.45 0	1.68 0	1.79 0	2.06 0	2.68 0
10	5.63-1	6.01-1	7.05-1	8.50-1	1.01 0	1.12 0	1.35 0	1.85 0
15	2.37-1	2.53-1	2.96-1	3.61-1	4.40-1	5.02-1	6.47-1	8.90-1
20	1.46-1	1.58-1	1.81-1	2.18-1	2.66-1	3.05-1	3.96-1	4.99-1
40	5.47-2	5.77-2	6.61-2	7.84-2	8.86-2	9.50-2	1.00-1	7.44-2
60	2.37-2	2.54-2	2.86-2	3.30-2	3.72-2	3.74-2	3.25-2	1.74-2
80	1.13-2	1.15-2	1.26-2	1.47-2	1.66-2	1.60-2	1.26-2	6.17-3
100	5.72-3	5.71-3	6.24-3	7.29-3	8.23-3	8.45-3	6.50-3	3.59-3
120	3.75-3	4.00-3	4.23-3	4.76-3	5.52-3	5.65-3	5.04-3	3.85-3
140	3.77-3	3.90-3	4.48-3	5.33-3	6.51-3	6.86-3	8.30-3	3.78-3
150	5.14-3	5.41-3	6.34-3	7.84-3	1.03-2	1.20-2	1.27-2	3.47-3
160	1.19-2	1.24-2	1.51-2	1.82-2	2.28-2	2.44-2	1.55-2	4.00-3
170	1.97-2	2.12-2	2.51-2	3.03-2	3.42-2	2.75-2	1.83-2	6.53-3
175	2.47-2	2.65-2	3.07-2	3.61-2	4.11-2	3.02-2	1.63-2	5.29-3
180	2.05-2	2.18-2	2.68-2	3.33-2	4.14-2	2.92-2	2.03-2	7.22-3

Table G3. Legendre Coefficients of Phase Functions

Index	Wavelength ( $\mu\text{m}$ )							
	0.40	0.44	0.55	0.75	1.04	1.24	1.65	2.20
0	1.00 0	1.00 0	1.00 0	1.00 0	1.00 0	1.00 0	1.00 0	1.00 0
1	2.63 0	2.62 0	2.57 0	2.49 0	2.41 0	2.40 0	2.45 0	2.66 0
2	4.07 0	4.02 0	3.90 0	3.72 0	3.53 0	3.48 0	3.54 0	3.94 0
3	5.23 0	5.13 0	4.88 0	4.51 0	4.13 0	4.01 0	4.04 0	4.74 0
4	6.54 0	6.39 0	6.04 0	5.52 0	4.98 0	4.73 0	4.53 0	5.23 0
5	7.67 0	7.47 0	6.98 0	6.27 0	5.52 0	5.17 0	4.82 0	5.50 0
6	8.91 0	8.68 0	8.08 0	7.20 0	6.25 0	5.75 0	5.11 0	5.65 0
7	1.00 1	9.71 0	8.98 0	7.90 0	6.75 0	6.16 0	5.37 0	5.68 0
8	1.12 1	1.08 1	9.95 0	8.69 0	7.33 0	6.58 0	5.56 0	5.68 0
9	1.22 1	1.18 1	1.08 1	9.34 0	7.77 0	6.95 0	5.74 0	5.61 0
10	1.32 1	1.28 1	1.16 1	9.99 0	8.20 0	7.23 0	5.86 0	5.53 0
11	1.42 1	1.37 1	1.24 1	1.06 1	8.56 0	7.53 0	5.96 0	5.43 0
12	1.52 1	1.46 1	1.31 1	1.11 1	8.88 0	7.72 0	6.02 0	5.31 0
13	1.61 1	1.54 1	1.38 1	1.16 1	9.16 0	7.91 0	6.06 0	5.18 0
14	1.69 1	1.62 1	1.45 1	1.20 1	9.39 0	8.05 0	6.06 0	5.03 0
15	1.78 1	1.70 1	1.51 1	1.24 1	9.60 0	8.17 0	6.04 0	4.88 0
16	1.86 1	1.77 1	1.57 1	1.28 1	9.76 0	8.23 0	5.99 0	4.71 0
17	1.93 1	1.84 1	1.62 1	1.31 1	9.90 0	8.28 0	5.94 0	4.55 0
18	2.00 1	1.91 1	1.67 1	1.34 1	1.00 1	8.32 0	5.85 0	4.37 0
19	2.07 1	1.97 1	1.72 1	1.37 1	1.01 1	8.32 0	5.76 0	4.19 0
20	2.14 1	2.03 1	1.76 1	1.39 1	1.02 1	8.31 0	5.64 0	4.00 0
21	2.20 1	2.09 1	1.80 1	1.41 1	1.02 1	8.27 0	5.53 0	3.82 0
22	2.26 1	2.14 1	1.84 1	1.43 1	1.02 1	8.23 0	5.40 0	3.63 0
23	2.32 1	2.19 1	1.88 1	1.44 1	1.02 1	8.16 0	5.26 0	3.45 0
24	2.38 1	2.24 1	1.91 1	1.46 1	1.02 1	8.08 0	5.12 0	3.27 0
25	2.43 1	2.28 1	1.94 1	1.47 1	1.02 1	7.99 0	4.97 0	3.09 0
26	2.48 1	2.33 1	1.97 1	1.48 1	1.01 1	7.88 0	4.82 0	2.91 0
27	2.53 1	2.37 1	1.99 1	1.49 1	1.00 1	7.77 0	4.66 0	2.74 0
28	2.57 1	2.41 1	2.02 1	1.49 1	9.97 0	7.65 0	4.51 0	2.56 0
29	2.62 1	2.44 1	2.04 1	1.50 1	9.89 0	7.52 0	4.35 0	2.40 0
30	2.66 1	2.48 1	2.06 1	1.50 1	9.79 0	7.38 0	4.19 0	2.23 0
31	2.70 1	2.51 1	2.08 1	1.50 1	9.69 0	7.25 0	4.02 0	2.08 0
32	2.73 1	2.54 1	2.09 1	1.50 1	9.56 0	7.09 0	3.86 0	1.92 0
33	2.77 1	2.57 1	2.10 1	1.50 1	9.45 0	6.94 0	3.70 0	1.77 0
34	2.80 1	2.59 1	2.12 1	1.50 1	9.31 0	6.78 0	3.54 0	1.63 0
35	2.83 1	2.62 1	2.13 1	1.49 1	9.18 0	6.63 0	3.37 0	1.49 0
36	2.86 1	2.64 1	2.14 1	1.49 1	9.03 0	6.46 0	3.22 0	1.36 0
37	2.89 1	2.66 1	2.14 1	1.48 1	8.90 0	6.30 0	3.06 0	1.23 0
38	2.91 1	2.68 1	2.15 1	1.47 1	8.74 0	6.13 0	2.91 0	1.11 0
39	2.94 1	2.70 1	2.16 1	1.47 1	8.59 0	5.97 0	2.76 0	9.93-1
40	2.96 1	2.72 1	2.16 1	1.46 1	8.43 0	5.80 0	2.61 0	8.84-1
41	2.98 1	2.73 1	2.16 1	1.45 1	8.26 0	5.63 0	2.47 0	7.76-1
42	3.00 1	2.74 1	2.16 1	1.44 1	8.09 0	5.45 0	2.33 0	6.80-1
43	3.02 1	2.76 1	2.16 1	1.42 1	7.93 0	5.29 0	2.19 0	5.86-1
44	3.03 1	2.77 1	2.16 1	1.41 1	7.76 0	5.12 0	2.06 0	5.04-1
45	3.05 1	2.78 1	2.16 1	1.40 1	7.59 0	4.95 0	1.93 0	4.22-1
46	3.06 1	2.79 1	2.16 1	1.39 1	7.42 0	4.78 0	1.81 0	3.54-1
47	3.08 1	2.79 1	2.15 1	1.37 1	7.24 0	4.62 0	1.69 0	2.85-1
48	3.09 1	2.80 1	2.15 1	1.36 1	7.06 0	4.45 0	1.57 0	2.32-1
49	3.10 1	2.80 1	2.14 1	1.34 1	6.89 0	4.28 0	1.46 0	1.81-1
50	3.11 1	2.81 1	2.14 1	1.33 1	6.71 0	4.12 0	1.35 0	1.47-1

Table G3. Continued

Index	Wavelength ( $\mu\text{m}$ )							
	0.40	0.44	0.55	0.75	1.04	1.24	1.65	2.20
51	3.11 1	2.81 1	2.13 1	1.31 1	6.54 0	3.96 0	1.25 0	1.13-1
52	3.12 1	2.81 1	2.12 1	1.30 1	6.37 0	3.80 0	1.15 0	9.23-2
53	3.13 1	2.81 1	2.11 1	1.28 1	6.19 0	3.65 0	1.06 0	6.84-2
54	3.13 1	2.81 1	2.10 1	1.26 1	6.02 0	3.49 0	9.66-1	5.45-2
55	3.13 1	2.81 1	2.09 1	1.25 1	5.84 0	3.34 0	8.77-1	3.62-2
56	3.14 1	2.81 1	2.08 1	1.23 1	5.67 0	3.19 0	7.95-1	2.73-2
57	3.14 1	2.81 1	2.07 1	1.21 1	5.50 0	3.04 0	7.15-1	1.54-2
58	3.14 1	2.81 1	2.06 1	1.19 1	5.33 0	2.90 0	6.44-1	1.23-2
59	3.14 1	2.80 1	2.05 1	1.18 1	5.16 0	2.77 0	5.71-1	4.76-3
60	3.14 1	2.80 1	2.03 1	1.16 1	4.99 0	2.63 0	5.05-1	3.34-3
61	3.14 1	2.79 1	2.02 1	1.14 1	4.82 0	2.49 0	4.36-1	-2.20-3
62	3.14 1	2.78 1	2.01 1	1.12 1	4.65 0	2.36 0	3.76-1	-4.21-3
63	3.13 1	2.78 1	1.99 1	1.10 1	4.49 0	2.23 0	3.20-1	-5.21-3
64	3.13 1	2.77 1	1.98 1	1.09 1	4.33 0	2.11 0	2.76-1	-4.52-3
65	3.13 1	2.76 1	1.96 1	1.07 1	4.18 0	2.00 0	2.36-1	-1.77-3
66	3.12 1	2.75 1	1.95 1	1.05 1	4.03 0	1.89 0	2.05-1	5.05-4
67	3.11 1	2.74 1	1.93 1	1.03 1	3.87 0	1.78 0	1.70-1	6.61-5
68	3.11 1	2.73 1	1.92 1	1.01 1	3.72 0	1.67 0	1.41-1	-1.52-3
69	3.10 1	2.72 1	1.90 1	9.92 0	3.57 0	1.56 0	1.08-1	-4.89-3
70	3.09 1	2.71 1	1.88 1	9.72 0	3.42 0	1.46 0	8.28-2	-7.50-3
71	3.08 1	2.70 1	1.86 1	9.54 0	3.28 0	1.36 0	6.19-2	-6.25-3
72	3.08 1	2.69 1	1.85 1	9.35 0	3.14 0	1.27 0	5.05-2	-3.54-3
73	3.07 1	2.68 1	1.83 1	9.17 0	3.01 0	1.19 0	3.97-2	5.95-4
74	3.06 1	2.66 1	1.81 1	8.99 0	2.88 0	1.11 0	3.48-2	4.04-3
75	3.05 1	2.65 1	1.79 1	8.80 0	2.75 0	1.02 0	2.20-2	3.12-3
76	3.04 1	2.64 1	1.78 1	8.61 0	2.62 0	9.38-1	1.30-2	8.58-4
77	3.02 1	2.62 1	1.76 1	8.42 0	2.49 0	8.53-1	2.01-3	-2.01-3
78	3.01 1	2.61 1	1.74 1	8.23 0	2.37 0	7.78-1	-3.42-3	-4.12-3
79	3.00 1	2.59 1	1.72 1	8.05 0	2.25 0	7.09-1	-3.09-3	-1.82-3
80	2.99 1	2.58 1	1.70 1	7.88 0	2.14 0	6.49-1	1.03-3	1.49-3
81	2.97 1	2.56 1	1.68 1	7.70 0	2.03 0	5.89-1	3.63-3	4.34-3
82	2.96 1	2.55 1	1.66 1	7.52 0	1.93 0	5.34-1	5.45-3	6.26-3
83	2.95 1	2.53 1	1.64 1	7.34 0	1.82 0	4.73-1	6.30-4	4.19-3
84	2.93 1	2.51 1	1.62 1	7.16 0	1.71 0	4.20-1	-4.32-3	1.32-3
85	2.92 1	2.50 1	1.60 1	6.98 0	1.61 0	3.67-1	-7.33-3	-1.76-4
86	2.90 1	2.48 1	1.59 1	6.81 0	1.52 0	3.25-1	-7.74-3	-1.01-3
87	2.89 1	2.46 1	1.57 1	6.64 0	1.43 0	2.85-1	-4.24-3	6.98-4
88	2.87 1	2.44 1	1.55 1	6.47 0	1.35 0	2.54-1	-4.66-4	2.44-3
89	2.86 1	2.43 1	1.53 1	6.30 0	1.26 0	2.15-1	-9.41-4	1.45-3
90	2.84 1	2.41 1	1.51 1	6.13 0	1.17 0	1.84-1	-3.11-3	-2.32-4
91	2.82 1	2.39 1	1.49 1	5.96 0	1.09 0	1.48-1	-6.94-3	-2.91-3
92	2.81 1	2.37 1	1.47 1	5.80 0	1.01 0	1.23-1	-9.41-3	-5.15-3
93	2.79 1	2.35 1	1.45 1	5.64 0	9.36-1	1.01-1	-6.57-3	-3.86-3
94	2.77 1	2.33 1	1.43 1	5.48 0	8.70-1	8.84-2	-2.10-3	-2.27-3
95	2.76 1	2.31 1	1.41 1	5.33 0	8.03-1	7.24-2	5.75-4	-1.86-3
96	2.74 1	2.29 1	1.39 1	5.17 0	7.40-1	5.94-2	9.16-4	-2.60-3
97	2.72 1	2.27 1	1.37 1	5.01 0	6.69-1	3.85-2	-4.77-3	-7.38-3
98	2.70 1	2.25 1	1.35 1	4.85 0	6.05-1	2.12-2	-1.17-2	-1.21-2
99	2.68 1	2.23 1	1.33 1	4.70 0	5.46-1	8.44-3	-1.27-2	-1.32-2
100	2.66 1	2.21 1	1.31 1	4.56 0	4.96-1	3.22-3	-1.12-2	-1.24-2



Table G3. Continued

Index	Wavelength ( $\mu\text{m}$ )							
	0.40	0.44	0.55	0.75	1.04	1.24	1.65	2.20
101	2.65 1	2.19 1	1.29 1	4.42 0	4.54-1	4.76-3	-2.67-3	-7.24-3
102	2.63 1	2.17 1	1.27 1	4.28 0	4.17-1	9.35-3	5.16-3	-2.36-3
103	2.61 1	2.15 1	1.25 1	4.14 0	3.73-1	5.63-3	4.62-3	-2.90-3
104	2.59 1	2.13 1	1.23 1	4.00 0	3.30-1	-3.62-4	-1.84-4	-5.43-3
105	2.57 1	2.11 1	1.21 1	3.86 0	2.82-1	-1.23-2	-1.05-2	-1.16-2
106	2.55 1	2.09 1	1.19 1	3.71 0	2.40-1	-2.19-2	-2.00-2	-1.67-2
107	2.53 1	2.07 1	1.17 1	3.59 0	2.09-1	-2.03-2	-1.78-2	-1.44-2
108	2.51 1	2.05 1	1.15 1	3.46 0	1.88-1	-1.37-2	-1.15-2	-9.52-3
109	2.49 1	2.03 1	1.13 1	3.35 0	1.72-1	-2.63-3	-6.14-4	-1.81-3
110	2.47 1	2.01 1	1.11 1	3.23 0	1.58-1	6.58-3	8.54-3	4.86-3
111	2.45 1	1.99 1	1.10 1	3.11 0	1.32-1	3.23-3	5.04-3	3.40-3
112	2.43 1	1.97 1	1.08 1	2.98 0	1.07-1	-3.93-3	-1.86-3	-1.73-4
113	2.41 1	1.95 1	1.06 1	2.86 0	7.93-2	-1.30-2	-1.10-2	-5.03-3
114	2.39 1	1.93 1	1.04 1	2.74 0	5.95-2	-1.87-2	-1.71-2	-8.40-3
115	2.37 1	1.91 1	1.02 1	2.63 0	5.12-2	-1.20-2	-1.09-2	-3.76-3
116	2.35 1	1.89 1	1.00 1	2.53 0	4.97-2	-2.13-3	-1.84-3	2.56-3
117	2.33 1	1.87 1	9.85 0	2.43 0	4.63-2	6.22-3	6.09-3	8.17-3
118	2.31 1	1.85 1	9.67 0	2.33 0	4.27-2	1.08-2	1.09-2	1.19-2
119	2.29 1	1.82 1	9.49 0	2.22 0	2.79-2	4.13-3	4.84-3	8.68-3
120	2.27 1	1.80 1	9.30 0	2.12 0	1.44-2	-3.97-3	-2.34-3	3.95-3
121	2.24 1	1.78 1	9.12 0	2.02 0	4.85-3	-7.92-3	-5.74-3	1.76-3
122	2.22 1	1.76 1	8.95 0	1.93 0	1.44-3	-7.58-3	-5.35-3	7.80-4
123	2.20 1	1.74 1	8.78 0	1.84 0	4.86-3	-9.44-5	1.97-3	4.26-3
124	2.18 1	1.72 1	8.61 0	1.76 0	9.69-3	7.18-3	9.02-3	7.87-3
125	2.16 1	1.70 1	8.44 0	1.67 0	6.58-3	6.51-3	8.64-3	6.52-3
126	2.14 1	1.68 1	8.26 0	1.58 0	1.01-3	2.04-3	4.79-3	4.05-3
127	2.12 1	1.66 1	8.09 0	1.49 0	-7.57-3	-5.51-3	-1.85-3	-3.74-4
128	2.10 1	1.64 1	7.92 0	1.41 0	-1.32-2	-1.06-2	-6.49-3	-3.94-3
129	2.08 1	1.62 1	7.75 0	1.34 0	-8.79-3	-5.68-3	-1.77-3	-1.52-3
130	2.06 1	1.60 1	7.59 0	1.27 0	-1.14-3	2.32-3	5.51-3	1.55-3
131	2.04 1	1.58 1	7.43 0	1.20 0	4.19-3	7.65-3	9.76-3	2.61-3
132	2.01 1	1.56 1	7.27 0	1.14 0	5.44-3	8.56-3	9.99-3	1.84-3
133	1.99 1	1.54 1	7.10 0	1.06 0	-4.17-3	-1.79-3	-4.69-4	-5.90-3
134	1.97 1	1.52 1	6.93 0	9.86-1	-1.57-2	-1.40-2	-1.27-2	-1.34-2
135	1.95 1	1.50 1	6.77 0	9.20-1	-1.85-2	-1.73-2	-1.56-2	-1.50-2
136	1.93 1	1.48 1	6.61 0	8.63-1	-1.60-2	-1.48-2	-1.35-2	-1.34-2
137	1.91 1	1.46 1	6.47 0	8.17-1	-1.51-3	-2.09-4	1.69-4	-4.32-3
138	1.89 1	1.44 1	6.33 0	7.74-1	1.26-2	1.42-2	1.38-2	4.30-3
139	1.87 1	1.42 1	6.17 0	7.22-1	1.41-2	1.53-2	1.37-2	4.15-3
140	1.85 1	1.40 1	6.02 0	6.66-1	8.45-3	9.19-3	7.31-3	5.74-4
141	1.83 1	1.38 1	5.86 0	6.03-1	-6.37-3	-6.47-3	-8.36-3	-8.98-3
142	1.80 1	1.36 1	5.70 0	5.45-1	-2.00-2	-2.06-2	-2.25-2	-1.71-2
143	1.78 1	1.34 1	5.56 0	5.04-1	-1.58-2	-1.63-2	-1.82-2	-1.32-2
144	1.76 1	1.32 1	5.42 0	4.71-1	-5.11-3	-5.00-3	-7.50-3	-5.50-3
145	1.74 1	1.30 1	5.29 0	4.46-1	1.28-2	1.38-2	1.05-2	7.02-3
146	1.72 1	1.28 1	5.16 0	4.22-1	2.72-2	2.88-2	2.55-2	1.77-2
147	1.70 1	1.26 1	5.02 0	3.81-1	2.22-2	2.39-2	2.03-2	1.54-2
148	1.68 1	1.25 1	4.87 0	3.37-1	1.11-2	1.25-2	9.55-3	9.50-3
149	1.66 1	1.23 1	4.73 0	2.92-1	-3.02-3	-2.02-3	-4.48-3	1.57-3
150	1.64 1	1.21 1	4.59 0	2.55-1	-1.21-2	-1.12-2	-1.38-2	-4.18-3

Table G3. Continued

Index	Wavelength ( $\mu\text{m}$ )							
	0.40	0.44	0.55	0.75	1.04	1.24	1.65	2.20
151	1.62 1	1.19 1	4.46 0	2.35-1	-2.28-3	-9.22-4	-3.67-3	2.68-3
152	1.60 1	1.17 1	4.34 0	2.23-1	1.24-2	1.45-2	1.09-2	1.23-2
153	1.58 1	1.15 1	4.22 0	2.09-1	2.43-2	2.73-2	2.35-2	2.05-2
154	1.56 1	1.14 1	4.10 0	1.92-1	3.09-2	3.42-2	3.08-2	2.62-2
155	1.54 1	1.12 1	3.97 0	1.61-1	1.99-2	2.33-2	2.07-2	2.06-2
156	1.52 1	1.10 1	3.84 0	1.31-1	7.32-3	1.03-2	8.64-3	1.31-2
157	1.50 1	1.08 1	3.72 0	1.08-1	9.84-4	3.76-3	2.51-3	9.55-3
158	1.48 1	1.06 1	3.60 0	9.28-2	1.49-3	4.25-3	2.33-3	8.05-3
159	1.46 1	1.05 1	3.49 0	8.77-2	1.26-2	1.57-2	1.30-2	1.35-2
160	1.44 1	1.03 1	3.39 0	8.48-2	2.38-2	2.71-2	2.33-2	1.91-2
161	1.42 1	1.01 1	3.28 0	7.15-2	2.22-2	2.55-2	2.17-2	1.68-2
162	1.40 1	9.93 0	3.16 0	5.51-2	1.52-2	1.82-2	1.49-2	1.27-2
163	1.38 1	9.75 0	3.05 0	3.49-2	3.12-3	5.78-3	3.65-3	5.68-3
164	1.36 1	9.58 0	2.93 0	1.98-2	-5.19-3	-2.73-3	-4.36-3	-6.24-5
165	1.34 1	9.41 0	2.84 0	1.85-2	1.73-3	4.25-3	2.33-3	3.77-3
166	1.33 1	9.25 0	2.75 0	2.31-2	1.34-2	1.62-2	1.32-2	8.67-3
167	1.31 1	9.09 0	2.65 0	2.49-2	2.13-2	2.40-2	1.97-2	1.07-2
168	1.29 1	8.93 0	2.56 0	2.20-2	2.28-2	2.51-2	2.01-2	9.76-3
169	1.27 1	8.75 0	2.45 0	4.64-3	7.06-3	8.62-3	3.77-3	-2.09-3
170	1.25 1	8.58 0	2.35 0	-1.44-2	-1.16-2	-1.09-2	-1.52-2	-1.39-2
171	1.23 1	8.41 0	2.25 0	-2.21-2	-1.76-2	-1.72-2	-2.05-2	-1.70-2
172	1.21 1	8.25 0	2.17 0	-2.13-2	-1.54-2	-1.47-2	-1.79-2	-1.55-2
173	1.20 1	8.10 0	2.10 0	-4.51-3	4.91-3	6.18-3	2.28-3	-2.54-3
174	1.18 1	7.96 0	2.03 0	1.27-2	2.50-2	2.69-2	2.25-2	9.71-3
175	1.16 1	7.81 0	1.95 0	1.37-2	2.59-2	2.77-2	2.22-2	8.85-3
176	1.14 1	7.64 0	1.86 0	5.35-3	1.64-2	1.75-2	1.25-2	2.84-3
177	1.12 1	7.47 0	1.77 0	-1.50-2	-7.14-3	-7.22-3	-1.15-2	-1.23-2
178	1.10 1	7.31 0	1.68 0	-3.32-2	-2.89-2	-2.97-2	-3.33-2	-2.54-2
179	1.09 1	7.16 0	1.61 0	-2.83-2	-2.40-2	-2.49-2	-2.76-2	-2.07-2
180	1.07 1	7.02 0	1.55 0	-1.41-2	-9.52-3	-9.54-3	-1.26-2	-1.03-2
181	1.05 1	6.89 0	1.50 0	9.59-3	1.59-2	1.69-2	1.34-2	7.34-3
182	1.04 1	6.76 0	1.45 0	2.84-2	3.60-2	3.78-2	3.47-2	2.22-2
183	1.02 1	6.61 0	1.38 0	2.25-2	2.74-2	2.91-2	2.62-2	1.80-2
184	1.00 1	6.45 0	1.30 0	8.01-3	9.71-3	1.06-2	9.32-3	8.44-3
185	9.85 0	6.29 0	1.22 0	-1.01-2	-1.21-2	-1.21-2	-1.22-2	-3.97-3
186	9.67 0	6.14 0	1.15 0	-2.12-2	-2.65-2	-2.70-2	-2.68-2	-1.31-2
187	9.51 0	6.01 0	1.11 0	-8.14-3	-1.28-2	-1.29-2	-1.25-2	-3.47-3
188	9.36 0	5.89 0	1.07 0	1.15-2	8.03-3	8.73-3	8.25-3	1.02-2
189	9.21 0	5.77 0	1.03 0	2.74-2	2.45-2	2.62-2	2.58-2	2.16-2
190	9.05 0	5.64 0	9.83-1	3.54-2	3.29-2	3.49-2	3.53-2	2.92-2
191	8.88 0	5.49 0	9.20-1	2.12-2	1.55-2	1.73-2	1.92-2	2.02-2
192	8.71 0	5.35 0	8.57-1	4.30-3	-4.43-3	-3.36-3	2.07-4	8.50-3
193	8.54 0	5.21 0	8.04-1	-4.01-3	-1.43-2	-1.37-2	-9.33-3	3.00-3
194	8.39 0	5.09 0	7.60-1	-3.15-3	-1.43-2	-1.37-2	-9.99-3	7.00-4
195	8.24 0	4.97 0	7.30-1	1.15-2	1.91-3	2.90-3	5.58-3	8.84-3
196	8.10 0	4.86 0	7.01-1	2.59-2	1.80-2	1.92-2	2.06-2	1.71-2
197	7.95 0	4.73 0	6.59-1	2.36-2	1.49-2	1.62-2	1.78-2	1.36-2
198	7.79 0	4.60 0	6.13-1	1.36-2	3.65-3	4.41-3	7.02-3	7.08-3
199	7.63 0	4.47 0	5.62-1	-3.10-3	-1.52-2	-1.49-2	-1.05-2	-3.86-3
200	7.47 0	4.34 0	5.18-1	-1.49-2	-2.86-2	-2.86-2	-2.32-2	-1.28-2

Table G3. Continued

Index	Wavelength ( $\mu\text{m}$ )							
	0.40	0.44	0.55	0.75	1.04	1.24	1.65	2.20
201	7.33 0	4.23 0	4.92-1	-6.65-3	-1.88-2	-1.87-2	-1.36-2	-7.24-3
202	7.20 0	4.13 0	4.73-1	7.94-3	-2.03-3	-1.42-3	2.46-3	3.45-5
203	7.06 0	4.03 0	4.52-1	1.84-2	9.93-3	1.06-2	1.25-2	3.47-3
204	6.92 0	3.92 0	4.24-1	1.98-2	1.24-2	1.26-2	1.37-2	2.54-3
205	6.77 0	3.79 0	3.79-1	-7.48-4	-1.05-2	-1.15-2	-9.97-3	-1.47-2
206	6.61 0	3.67 0	3.32-1	-2.57-2	-3.81-2	-4.02-2	-3.76-2	-3.21-2
207	6.47 0	3.56 0	2.99-1	-3.47-2	-4.73-2	-5.00-2	-4.59-2	-3.70-2
208	6.33 0	3.45 0	2.77-1	-3.28-2	-4.47-2	-4.70-2	-4.28-2	-3.54-2
209	6.22 0	3.37 0	2.77-1	-7.51-3	-1.51-2	-1.67-2	-1.35-2	-1.67-2
210	6.10 0	3.29 0	2.77-1	1.75-2	1.42-2	1.36-2	1.59-2	9.87-4
211	5.97 0	3.19 0	2.58-1	1.92-2	1.65-2	1.55-2	1.63-2	4.95-5
212	5.84 0	3.09 0	2.28-1	6.57-3	3.54-3	1.48-3	2.91-3	-8.27-3
213	5.69 0	2.97 0	1.84-1	-2.36-2	-2.98-2	-3.37-2	-3.13-2	-3.00-2
214	5.54 0	2.86 0	1.44-1	-5.14-2	-6.05-2	-6.57-2	-6.25-2	-4.89-2
215	5.42 0	2.77 0	1.32-1	-4.60-2	-5.30-2	-5.84-2	-5.43-2	-4.22-2
216	5.31 0	2.69 0	1.33-1	-2.75-2	-3.15-2	-3.61-2	-3.27-2	-2.74-2
217	5.21 0	2.63 0	1.46-1	4.87-3	5.89-3	2.56-3	4.85-3	-2.26-3
218	5.11 0	2.56 0	1.54-1	3.00-2	3.55-2	3.30-2	3.54-2	1.90-2
219	4.98 0	2.47 0	1.32-1	1.98-2	2.43-2	2.12-2	2.35-2	1.29-2
220	4.85 0	2.37 0	1.01-1	-2.74-3	-1.10-4	-4.63-3	-5.00-4	-5.98-4
221	4.72 0	2.27 0	6.66-2	-2.98-2	-2.98-2	-3.60-2	-3.06-2	-1.79-2
222	4.59 0	2.18 0	4.14-2	-4.67-2	-4.88-2	-5.60-2	-5.07-2	-3.03-2
223	4.49 0	2.12 0	4.74-2	-2.85-2	-2.70-2	-3.40-2	-2.91-2	-1.58-2
224	4.40 0	2.06 0	6.20-2	-7.56-4	4.71-3	-1.40-3	1.67-3	4.36-3
225	4.31 0	2.01 0	7.21-2	2.13-2	2.99-2	2.48-2	2.71-2	2.09-2
226	4.21 0	1.94 0	7.33-2	3.20-2	4.29-2	3.79-2	4.08-2	3.19-2
227	4.09 0	1.86 0	4.75-2	1.10-2	1.91-2	1.34-2	1.77-2	1.91-2
228	3.97 0	1.77 0	1.92-2	-1.36-2	-8.56-3	-1.54-2	-9.46-3	2.65-3
229	3.86 0	1.69 0	3.45-3	-2.47-2	-2.05-2	-2.82-2	-2.18-2	-4.05-3
230	3.76 0	1.63 0	-3.61-4	-2.21-2	-1.80-2	-2.58-2	-2.10-2	-5.83-3
231	3.67 0	1.58 0	1.41-2	9.64-4	8.33-3	1.07-3	3.59-3	7.74-3
232	3.59 0	1.54 0	2.88-2	2.37-2	3.41-2	2.72-2	2.72-2	2.13-2
233	3.49 0	1.48 0	2.23-2	2.19-2	3.14-2	2.47-2	2.41-2	1.73-2
234	3.39 0	1.41 0	6.65-3	8.64-3	1.64-2	9.05-3	9.20-3	8.74-3
235	3.28 0	1.33 0	-1.72-2	-1.44-2	-9.92-3	-1.79-2	-1.60-2	-6.55-3
236	3.18 0	1.27 0	-3.45-2	-3.01-2	-2.85-2	-3.65-2	-3.39-2	-1.88-2
237	3.10 0	1.22 0	-2.54-2	-1.59-2	-1.25-2	-2.01-2	-1.86-2	-9.39-3
238	3.02 0	1.19 0	-7.77-3	7.96-3	1.37-2	7.36-3	6.38-3	2.87-3
239	2.95 0	1.15 0	5.52-3	2.64-2	3.36-2	2.80-2	2.35-2	1.01-2
240	2.87 0	1.11 0	8.43-3	3.22-2	3.98-2	3.41-2	2.80-2	1.10-2
241	2.77 0	1.04 0	-1.71-2	5.21-3	8.20-3	1.64-3	-4.71-3	-1.23-2
242	2.66 0	9.68-1	-4.76-2	-2.82-2	-3.04-2	-3.79-2	-4.33-2	-3.63-2
243	2.57 0	9.14-1	-5.90-2	-3.96-2	-4.37-2	-5.12-2	-5.51-2	-4.30-2
244	2.49 0	8.73-1	-5.68-2	-3.51-2	-4.01-2	-4.61-2	-5.04-2	-4.03-2
245	2.44 0	8.61-1	-2.48-2	3.46-3	2.91-3	-1.05-3	-7.44-3	-1.28-2
246	2.40 0	8.49-1	7.40-3	4.20-2	4.58-2	4.42-2	3.61-2	1.37-2
247	2.32 0	8.14-1	1.10-2	4.74-2	5.03-2	4.93-2	3.86-2	1.37-2
248	2.24 0	7.65-1	-2.18-3	3.24-2	3.30-2	3.16-2	2.14-2	3.22-3
249	2.14 0	6.96-1	-3.80-2	-8.64-3	-1.44-2	-1.73-2	-2.64-2	-2.69-2
250	2.04 0	6.32-1	-7.06-2	-4.61-2	-5.81-2	-6.17-2	-6.99-2	-5.31-2

Table G3. Concluded

Index	Wavelength ( $\mu\text{m}$ )							
	0.40	0.44	0.55	0.75	1.04	1.24	1.65	2.20
251	1.98 0	6.05-1	-6.27-2	-3.69-2	-4.78-2	-5.06-2	-5.77-2	-4.33-2
252	1.93 0	5.93-1	-3.88-2	-8.76-3	-1.74-2	-1.77-2	-2.62-2	-2.20-2
253	1.90 0	5.97-1	1.95-3	3.87-2	3.54-2	3.79-2	2.76-2	1.39-2
254	1.86 0	5.94-1	3.41-2	7.58-2	7.72-2	8.19-2	7.15-2	4.42-2
255	1.79 0	5.54-1	2.23-2	6.21-2	6.01-2	6.50-2	5.46-2	3.53-2
256	1.70 0	5.02-1	-4.08-3	3.08-2	2.45-2	2.83-2	2.04-2	1.61-2
257	1.61 0	4.46-1	-3.57-2	-6.73-3	-1.84-2	-1.60-2	-2.17-2	-8.02-3
258	1.54 0	4.02-1	-5.47-2	-2.94-2	-4.53-2	-4.35-2	-4.92-2	-2.49-2
259	1.50 0	3.99-1	-2.99-2	-1.75-3	-1.39-2	-1.08-2	-1.67-2	-3.20-3
260	1.47 0	4.06-1	6.25-3	3.95-2	3.20-2	3.69-2	2.86-2	2.64-2
261	1.44 0	4.06-1	3.39-2	7.11-2	6.67-2	7.38-2	6.47-2	4.98-2
262	1.40 0	3.95-1	4.76-2	8.59-2	8.38-2	9.12-2	8.33-2	6.48-2
263	1.32 0	3.50-1	2.11-2	5.43-2	4.71-2	5.40-2	4.86-2	4.52-2
264	1.24 0	3.01-1	-9.49-3	1.77-2	5.38-3	1.07-2	8.16-3	2.09-2
265	1.18 0	2.70-1	-2.14-2	2.13-3	-1.19-2	-7.48-3	-8.55-3	1.21-2
266	1.14 0	2.55-1	-1.63-2	6.92-3	-7.41-3	-3.04-3	-5.83-3	1.08-2
267	1.12 0	2.65-1	1.50-2	4.17-2	3.20-2	3.74-2	3.21-2	3.23-2
268	1.10 0	2.74-1	4.58-2	7.58-2	7.07-2	7.64-2	6.84-2	5.34-2
269	1.05 0	2.55-1	4.35-2	7.21-2	6.57-2	7.15-2	6.33-2	4.74-2
270	9.90-1	2.24-1	2.68-2	5.12-2	4.25-2	4.67-2	4.05-2	3.43-2
271	9.21-1	1.82-1	-3.31-3	1.48-2	1.39-3	4.23-3	1.57-3	1.07-2
272	8.61-1	1.48-1	-2.41-2	-1.05-2	-2.77-2	-2.57-2	-2.66-2	-8.25-3
273	8.36-1	1.51-1	-5.59-3	9.13-3	-4.80-3	-2.56-3	-3.86-3	5.96-3
274	8.22-1	1.65-1	2.55-2	4.39-2	3.43-2	3.76-2	3.37-2	2.49-2
275	8.04-1	1.74-1	5.05-2	7.13-2	6.51-2	6.88-2	6.09-2	3.73-2
276	7.75-1	1.71-1	5.99-2	8.03-2	7.61-2	7.89-2	6.96-2	4.02-2
277	7.09-1	1.29-1	2.56-2	3.91-2	2.92-2	2.98-2	2.16-2	6.33-3
278	6.38-1	8.03-2	-1.69-2	-1.18-2	-2.81-2	-2.99-2	-3.58-2	-2.93-2
279	5.91-1	5.53-2	-3.34-2	-3.26-2	-5.04-2	-5.35-2	-5.59-2	-4.09-2
280	5.60-1	4.84-2	-2.98-2	-2.93-2	-4.72-2	-4.94-2	-5.16-2	-3.89-2
281	5.68-1	8.14-2	1.77-2	2.43-2	1.43-2	1.40-2	9.78-3	2.24-4
282	5.77-1	1.15-1	6.59-2	7.89-2	7.70-2	7.88-2	7.27-2	3.82-2
283	5.51-1	1.13-1	7.23-2	8.53-2	8.36-2	8.54-2	7.63-2	3.82-2
284	5.07-1	8.91-2	5.38-2	6.20-2	5.89-2	5.88-2	5.12-2	2.28-2
285	4.35-1	3.48-2	7.97-4	-8.86-4	-1.18-2	-1.50-2	-2.00-2	-2.22-2
286	3.67-1	-1.51-2	-4.76-2	-5.84-2	-7.68-2	-8.22-2	-8.51-2	-6.18-2
287	3.50-1	-1.27-2	-3.79-2	-4.86-2	-6.37-2	-6.91-2	-6.98-2	-4.94-2
288	3.52-1	1.07-2	-4.48-3	-1.05-2	-2.07-2	-2.36-2	-2.60-2	-2.04-2
289	3.75-1	5.60-2	5.29-2	5.53-2	5.45-2	5.47-2	4.99-2	2.93-2
290	3.89-1	9.05-2	9.76-2	1.06-1	1.14-1	1.16-1	1.11-1	7.09-2
291	3.49-1	6.72-2	7.70-2	8.17-2	8.56-2	8.72-2	8.27-2	5.47-2
292	2.93-1	2.54-2	3.48-2	3.14-2	3.03-2	2.95-2	2.89-2	2.38-2
293	2.31-1	-2.21-2	-1.42-2	-2.68-2	-3.43-2	-3.78-2	-3.48-2	-1.32-2
294	1.86-1	-5.28-2	-4.43-2	-6.25-2	-7.49-2	-7.95-2	-7.62-2	-3.91-2
295	1.97-1	-2.47-2	-9.04-3	-2.29-2	-2.80-2	-3.12-2	-2.84-2	-7.37-3
296	2.21-1	1.80-2	4.27-2	3.66-2	3.98-2	3.91-2	3.84-2	3.53-2
297	2.34-1	4.79-2	7.99-2	7.97-2	8.86-2	9.06-2	8.81-2	6.67-2
298	2.31-1	5.88-2	9.50-2	9.63-2	1.09-1	1.12-1	1.11-1	8.49-2
299	1.76-1	1.57-2	4.94-2	4.32-2	4.92-2	5.02-2	5.28-2	5.10-2
300	1.18-1	-3.25-2	-2.36-3	-1.76-2	-1.87-2	-2.00-2	-1.32-2	1.09-2

Appendix H  
Soot Aerosol Model

Table H1. Optical Parameters

Wavelength ( $\mu\text{m}$ )	Extinction Cross Section ( $\text{m}^2$ )	Asymmetry Factor	Single Scattering Albedo	180 Degree Backscatter ( $\text{m}^2/\text{sr}$ )	Refractive Indices	
0.40	8.60-16	0.396	0.268	8.99-18	1.75	-4.60-1
0.44	7.60-16	0.377	0.249	7.93-18	1.75	-4.55-1
0.55	5.54-16	0.335	0.209	5.60-18	1.75	-4.40-1
0.75	3.57-16	0.276	0.147	3.08-18	1.75	-4.30-1
1.04	2.35-16	0.214	0.088	1.45-18	1.75	-4.39-1
1.24	1.91-16	0.184	0.064	9.28-19	1.76	-4.48-1
1.65	1.39-16	0.139	0.036	4.24-19	1.78	-4.69-1
2.20	1.03-16	0.101	0.018	1.80-19	1.81	-4.98-1

Table H2. Phase Functions

Scatter Angle (deg)	Wavelength ( $\mu\text{m}$ )							
	0.40	0.44	0.55	0.75	1.04	1.24	1.65	2.20
0	3.33-1	3.13-1	2.74-1	2.31-1	1.97-1	1.83-1	1.65-1	1.50-1
1	3.33-1	3.13-1	2.74-1	2.31-1	1.97-1	1.83-1	1.65-1	1.50-1
2	3.33-1	3.12-1	2.74-1	2.31-1	1.97-1	1.83-1	1.64-1	1.50-1
4	3.30-1	3.11-1	2.73-1	2.30-1	1.97-1	1.83-1	1.64-1	1.50-1
6	3.27-1	3.08-1	2.70-1	2.29-1	1.96-1	1.82-1	1.63-1	1.50-1
8	3.22-1	3.04-1	2.68-1	2.27-1	1.94-1	1.81-1	1.62-1	1.49-1
10	3.16-1	2.99-1	2.64-1	2.24-1	1.93-1	1.79-1	1.61-1	1.48-1
15	2.97-1	2.82-1	2.52-1	2.16-1	1.87-1	1.74-1	1.57-1	1.45-1
20	2.73-1	2.61-1	2.36-1	2.06-1	1.79-1	1.68-1	1.52-1	1.40-1
40	1.70-1	1.67-1	1.60-1	1.49-1	1.37-1	1.31-1	1.22-1	1.14-1
60	9.60-2	9.64-2	9.66-2	9.56-2	9.28-2	9.09-2	8.77-2	8.45-2
80	5.64-2	5.74-2	5.96-2	6.18-2	6.32-2	6.36-2	6.39-2	6.37-2
100	3.91-2	4.04-2	4.33-2	4.72-2	5.10-2	5.28-2	5.53-2	5.72-2
120	3.43-2	3.60-2	3.99-2	4.57-2	5.19-2	5.51-2	5.98-2	6.38-2
140	3.52-2	3.74-2	4.27-2	5.06-2	5.94-2	6.40-2	7.09-2	7.71-2
150	3.65-2	3.90-2	4.48-2	5.36-2	6.36-2	6.87-2	7.67-2	8.38-2
160	3.78-2	4.04-2	4.67-2	5.62-2	6.70-2	7.27-2	8.14-2	8.93-2
170	3.87-2	4.15-2	4.80-2	5.80-2	6.93-2	7.53-2	8.45-2	9.29-2
175	3.90-2	4.17-2	4.84-2	5.84-2	6.99-2	7.59-2	8.53-2	9.38-2
180	3.91-2	4.18-2	4.85-2	5.86-2	7.01-2	7.62-2	8.56-2	9.41-2

Table H3. Legendre Coefficients of Phase Functions

Index	Wavelength ( $\mu\text{m}$ )							
	0.40	0.44	0.55	0.75	1.04	1.24	1.65	2.20
0	1.00 0	1.00 0	1.00 0	1.00 0	1.00 0	1.00 0	1.00 0	1.00 0
1	1.19 0	1.13 0	1.00 0	8.27-1	6.43-1	5.52-1	4.18-1	3.03-1
2	1.01 0	9.60-1	8.57-1	7.37-1	6.43-1	6.05-1	5.60-1	5.32-1
3	5.06-1	4.53-1	3.49-1	2.34-1	1.49-1	1.17-1	7.69-2	5.03-2
4	2.53-1	2.15-1	1.46-1	7.77-2	3.72-2	2.48-2	1.18-2	5.25-3
5	1.21-1	9.74-2	5.75-2	2.28-2	7.56-3	4.21-3	1.43-3	4.45-4
6	5.98-2	4.50-2	2.27-2	6.17-3	1.26-3	5.19-4	4.54-5	-5.15-5
7	2.83-2	1.95-2	7.88-3	1.27-3	1.69-4	6.51-5	-1.45-5	-1.01-5
8	1.32-2	8.13-3	2.47-3	2.57-4	5.27-5	5.65-5	2.53-5	2.59-5
9	5.55-3	2.92-3	6.10-4	6.39-5	2.79-5	2.15-5	1.52-5	-5.53-6
10	2.17-3	9.69-4	1.98-4	9.84-5	9.74-5	8.53-5	1.12-4	8.67-5
11	6.64-4	2.16-4	2.03-5	3.01-6	9.89-6	-6.11-6	3.33-5	8.39-6
12	1.15-4	-4.01-5	-6.39-5	-8.01-5	-6.50-5	-8.41-5	-3.23-5	-5.31-5
13	-1.76-5	-7.41-5	-5.71-5	-5.13-5	-4.00-5	-3.82-5	-1.85-5	-7.94-6
14	-6.60-5	-9.60-5	-8.21-5	-7.20-5	-8.24-5	-7.70-5	-9.70-5	-7.73-5
15	2.25-5	4.63-6	9.87-6	2.45-5	1.50-5	2.01-5	-6.03-6	1.55-5
16	1.33-4	1.25-4	1.10-4	1.32-4	1.32-4	1.50-4	1.21-4	1.52-4
17	7.13-5	6.98-5	4.79-5	4.83-5	4.03-5	4.20-5	2.62-5	3.07-5
18	2.04-5	2.81-5	2.42-5	2.43-5	2.52-5	3.04-5	4.28-5	3.37-5
19	-8.18-5	-6.42-5	-5.50-5	-6.13-5	-5.76-5	-4.30-5	-2.70-5	-2.12-5
20	-2.02-4	-1.84-4	-1.83-4	-2.05-4	-2.10-4	-2.11-4	-2.14-4	-2.05-4
21	-6.30-5	-3.87-5	-3.93-5	-3.94-5	-3.24-5	-2.62-5	-3.74-5	-1.07-5
22	9.23-5	1.12-4	8.63-5	9.48-5	1.07-4	1.05-4	6.98-5	1.05-4
23	1.51-4	1.62-4	1.15-4	1.10-4	1.11-4	9.90-5	4.73-5	5.38-5
24	2.46-4	2.60-4	2.39-4	2.52-4	2.76-4	2.89-4	2.64-4	2.69-4
25	-1.26-5	-8.65-6	-1.11-5	-1.89-5	-1.66-6	1.21-5	2.96-6	-1.98-5
26	-3.02-4	-3.06-4	-2.76-4	-2.98-4	-2.98-4	-2.80-4	-2.73-4	-3.08-4
27	-2.69-4	-2.79-4	-2.13-4	-2.01-4	-1.75-4	-1.44-4	-9.74-5	-1.01-4
28	-3.16-4	-3.35-4	-3.05-4	-3.24-4	-3.51-4	-3.62-4	-3.52-4	-3.60-4
29	6.23-5	4.51-5	5.67-5	5.48-5	1.72-5	7.70-7	3.78-6	2.24-5
30	5.00-4	5.02-4	4.97-4	5.31-4	5.13-4	4.98-4	5.02-4	5.49-4
31	3.51-4	3.50-4	3.09-4	3.00-4	2.19-4	1.85-4	1.44-4	1.50-4
32	2.64-4	2.79-4	2.60-4	2.87-4	2.64-4	2.76-4	2.81-4	3.01-4
33	-1.94-4	-1.80-4	-1.70-4	-1.39-4	-1.29-4	-9.26-5	-5.77-5	-4.75-5
34	-7.16-4	-7.18-4	-7.05-4	-7.28-4	-7.28-4	-6.98-4	-6.72-4	-7.16-4
35	-4.19-4	-4.19-4	-3.58-4	-3.44-4	-2.63-4	-2.16-4	-1.46-4	-1.55-4
36	-2.28-4	-2.51-4	-2.19-4	-2.74-4	-2.46-4	-2.52-4	-2.36-4	-2.81-4
37	2.90-4	2.60-4	2.63-4	1.82-4	1.84-4	1.31-4	1.01-4	5.05-5
38	8.90-4	8.78-4	8.95-4	8.77-4	9.17-4	8.72-4	8.65-4	8.78-4
39	4.31-4	4.21-4	3.78-4	3.14-4	2.75-4	1.97-4	1.35-4	1.18-4
40	8.80-5	9.92-5	8.12-5	9.24-5	9.62-5	6.77-5	5.76-5	9.01-5
41	-3.78-4	-3.39-4	-3.27-4	-2.65-4	-2.23-4	-1.98-4	-1.55-4	-9.70-5
42	-9.32-4	-9.13-4	-9.23-4	-9.15-4	-9.36-4	-9.17-4	-9.09-4	-9.11-4
43	-3.72-4	-3.45-4	-3.12-4	-2.61-4	-2.27-4	-1.71-4	-1.21-4	-9.92-5
44	1.28-4	1.29-4	1.55-4	1.51-4	1.50-4	1.70-4	1.77-4	1.55-4
45	4.61-4	4.25-4	4.12-4	3.42-4	2.89-4	2.57-4	1.99-4	1.36-4
46	9.09-4	8.83-4	9.08-4	8.99-4	9.30-4	9.06-4	8.98-4	9.01-4
47	2.88-4	2.36-4	2.22-4	1.78-4	1.73-4	1.20-4	7.94-5	6.80-5
48	-2.76-4	-3.12-4	-3.32-4	-3.40-4	-3.30-4	-3.76-4	-3.85-4	-3.66-4
49	-3.73-4	-3.83-4	-3.68-4	-3.08-4	-2.49-4	-2.44-4	-1.93-4	-1.34-4
50	-5.42-4	-5.46-4	-5.76-4	-5.62-4	-5.98-4	-6.11-4	-6.01-4	-6.04-4

Table H3. Concluded

Index	Wavelength ( $\mu\text{m}$ )							
	0.40	0.44	0.55	0.75	1.04	1.24	1.65	2.20
51	3.90-5	5.56-5	3.81-5	5.71-5	6.44-6	1.24-5	2.30-5	5.78-6
52	6.52-4	6.82-4	6.84-4	7.18-4	6.77-4	7.06-4	7.24-4	7.04-4
53	3.93-4	4.10-4	3.69-4	3.32-4	2.35-4	2.29-4	1.88-4	1.25-4
54	2.21-4	2.35-4	2.32-4	2.36-4	2.28-4	2.58-4	2.50-4	2.49-4
55	-2.74-4	-2.63-4	-2.57-4	-2.35-4	-1.82-4	-1.45-4	-1.23-4	-8.77-5
56	-8.28-4	-8.52-4	-8.84-4	-9.21-4	-9.03-4	-8.96-4	-9.35-4	-9.16-4
57	-2.27-4	-2.42-4	-2.38-4	-2.29-4	-1.60-4	-1.33-4	-1.28-4	-8.77-5
58	3.60-4	3.38-4	3.27-4	3.09-4	3.33-4	3.41-4	3.07-4	3.11-4
59	6.17-4	5.78-4	5.38-4	4.55-4	3.71-4	3.44-4	2.53-4	1.74-4
60	1.01-3	1.01-3	1.04-3	1.06-3	1.07-3	1.10-3	1.11-3	1.08-3
61	3.90-5	3.01-5	5.33-5	5.32-5	2.32-5	5.32-5	5.17-5	1.53-5
62	-9.87-4	-9.93-4	-9.71-4	-9.71-4	-9.93-4	-9.60-4	-9.30-4	-9.58-4
63	-9.42-4	-9.19-4	-8.27-4	-7.08-4	-5.93-4	-4.99-4	-3.68-4	-2.77-4
64	-1.13-3	-1.15-3	-1.15-3	-1.17-3	-1.20-3	-1.19-3	-1.18-3	-1.17-3
65	1.38-4	1.31-4	1.15-4	1.01-4	7.09-5	5.05-5	4.41-5	5.16-5
66	1.49-3	1.50-3	1.50-3	1.52-3	1.52-3	1.50-3	1.49-3	1.53-3
67	1.08-3	1.06-3	9.61-4	8.41-4	6.80-4	5.72-4	4.40-4	3.47-4
68	9.32-4	9.56-4	9.54-4	9.94-4	1.01-3	9.94-4	9.94-4	1.02-3
69	-4.91-4	-4.50-4	-4.21-4	-3.45-4	-2.67-4	-2.42-4	-1.80-4	-1.32-4
70	-2.08-3	-2.06-3	-2.08-3	-2.08-3	-2.07-3	-2.08-3	-2.06-3	-2.08-3
71	-1.28-3	-1.22-3	-1.10-3	-9.49-4	-7.49-4	-6.57-4	-4.96-4	-3.89-4
72	-7.81-4	-7.66-4	-7.35-4	-7.73-4	-7.57-4	-7.72-4	-7.58-4	-7.95-4
73	6.59-4	6.43-4	6.43-4	5.19-4	4.36-4	3.66-4	2.83-4	1.80-4
74	2.30-3	2.31-3	2.39-3	2.35-3	2.38-3	2.36-3	2.36-3	2.33-3
75	1.18-3	1.13-3	1.09-3	8.99-4	7.38-4	6.28-4	4.78-4	3.36-4
76	3.58-4	3.42-4	3.76-4	3.44-4	3.52-4	3.38-4	3.36-4	3.27-4
77	-8.44-4	-8.33-4	-7.58-4	-6.59-4	-5.34-4	-4.57-4	-3.55-4	-2.62-4
78	-2.26-3	-2.28-3	-2.31-3	-2.32-3	-2.35-3	-2.33-3	-2.33-3	-2.33-3
79	-8.84-4	-8.56-4	-8.17-4	-6.80-4	-5.70-4	-4.65-4	-3.56-4	-2.63-4

Appendix I  
Oceanic Aerosol Model

Table I1. Optical Parameters

Wavelength ( $\mu\text{m}$ )	Extinction Cross Section ( $\text{m}^2$ )	Asymmetry Factor	Single Scattering Albedo	180 Degree Backscatter ( $\text{m}^2/\text{sr}$ )	Refractive Indices	
0.40	3.19-12	0.791	1.000	1.90-13	1.39	-9.90-9
0.44	3.24-12	0.786	1.000	1.59-13	1.38	-8.31-9
0.55	3.33-12	0.778	1.000	1.89-13	1.38	-4.26-9
0.75	3.41-12	0.776	1.000	1.36-13	1.38	-4.01-7
1.04	3.48-12	0.773	0.999	1.13-13	1.37	-5.42-5
1.24	3.47-12	0.774	0.998	9.97-14	1.37	-1.21-4
1.65	3.32-12	0.779	0.997	7.05-14	1.36	-2.72-4
2.20	2.95-12	0.791	0.991	3.66-14	1.34	-8.94-4

Table I2. Phase Functions

Scatter Angle (deg)	Wavelength ( $\mu\text{m}$ )							
	0.40	0.44	0.55	0.75	1.04	1.24	1.65	2.20
0	4.38 1	3.59 1	2.34 1	1.31 1	7.33 0	5.67 0	3.85 0	2.76 0
1	3.55 1	3.02 1	2.09 1	1.23 1	7.11 0	5.55 0	3.81 0	2.74 0
2	2.03 1	1.89 1	1.53 1	1.04 1	6.50 0	5.21 0	3.68 0	2.69 0
4	6.11 0	6.20 0	6.08 0	5.70 0	4.66 0	4.10 0	3.21 0	2.49 0
6	2.82 0	2.87 0	3.00 0	3.02 0	2.99 0	2.90 0	2.60 0	2.20 0
8	1.59 0	1.65 0	1.76 0	1.90 0	1.98 0	2.00 0	2.01 0	1.88 0
10	1.04 0	1.09 0	1.18 0	1.33 0	1.44 0	1.46 0	1.54 0	1.57 0
15	5.33-1	5.55-1	6.02-1	7.00-1	7.74-1	8.12-1	8.81-1	9.58-1
20	3.59-1	3.68-1	3.96-1	4.31-1	4.87-1	5.13-1	5.59-1	6.13-1
40	1.07-1	1.08-1	1.11-1	1.12-1	1.18-1	1.21-1	1.25-1	1.28-1
60	3.42-2	3.60-2	3.65-2	3.66-2	3.74-2	3.71-2	3.70-2	3.60-2
80	1.31-2	1.26-2	1.38-2	1.49-2	1.46-2	1.45-2	1.45-2	1.37-2
100	6.98-3	6.84-3	7.31-3	7.28-3	8.05-3	8.05-3	8.07-3	7.61-3
120	4.68-3	5.40-3	6.06-3	6.10-3	6.89-3	6.79-3	6.89-3	6.60-3
140	9.70-3	1.06-2	1.16-2	1.09-2	1.16-2	1.12-2	1.05-2	9.00-3
150	2.28-2	2.37-2	2.09-2	2.04-2	1.78-2	1.64-2	1.40-2	1.10-2
160	2.45-2	2.42-2	2.54-2	2.39-2	2.16-2	2.03-2	1.73-2	1.29-2
170	3.34-2	3.46-2	3.50-2	3.12-2	2.52-2	2.30-2	1.79-2	1.14-2
175	4.58-2	3.76-2	3.96-2	2.67-2	2.13-2	1.78-2	1.40-2	1.01-2
180	5.94-2	4.93-2	5.67-2	4.01-2	3.26-2	2.88-2	2.13-2	1.25-2



Table I3. Legendre Coefficients of Phase Functions

Index	Wavelength ( $\mu\text{m}$ )							
	0.40	0.44	0.55	0.75	1.04	1.24	1.65	2.20
0	1.00 0	1.00 0	1.00 0	1.00 0	1.00 0	1.00 0	1.00 0	1.00 0
1	2.37 0	2.36 0	2.33 0	2.33 0	2.32 0	2.32 0	2.34 0	2.37 0
2	3.50 0	3.47 0	3.41 0	3.34 0	3.27 0	3.24 0	3.21 0	3.20 0
3	3.87 0	3.82 0	3.71 0	3.60 0	3.48 0	3.42 0	3.36 0	3.34 0
4	4.46 0	4.37 0	4.19 0	3.97 0	3.69 0	3.57 0	3.40 0	3.26 0
5	4.73 0	4.64 0	4.38 0	4.06 0	3.66 0	3.48 0	3.24 0	3.00 0
6	5.16 0	5.04 0	4.68 0	4.20 0	3.66 0	3.40 0	3.04 0	2.68 0
7	5.55 0	5.39 0	4.93 0	4.31 0	3.63 0	3.31 0	2.85 0	2.38 0
8	5.88 0	5.67 0	5.14 0	4.36 0	3.55 0	3.18 0	2.63 0	2.07 0
9	6.25 0	5.99 0	5.33 0	4.45 0	3.50 0	3.08 0	2.45 0	1.82 0
10	6.58 0	6.26 0	5.51 0	4.48 0	3.41 0	2.95 0	2.25 0	1.57 0
11	6.82 0	6.48 0	5.63 0	4.49 0	3.33 0	2.84 0	2.08 0	1.37 0
12	7.12 0	6.74 0	5.81 0	4.51 0	3.25 0	2.72 0	1.90 0	1.16 0
13	7.29 0	6.86 0	5.86 0	4.47 0	3.15 0	2.60 0	1.75 0	1.01 0
14	7.54 0	7.06 0	5.95 0	4.44 0	3.04 0	2.47 0	1.58 0	8.45-1
15	7.66 0	7.15 0	5.98 0	4.38 0	2.92 0	2.34 0	1.45 0	7.21-1
16	7.81 0	7.26 0	6.00 0	4.31 0	2.80 0	2.21 0	1.30 0	5.95-1
17	7.93 0	7.35 0	6.03 0	4.25 0	2.69 0	2.09 0	1.18 0	4.98-1
18	8.01 0	7.39 0	6.01 0	4.15 0	2.56 0	1.95 0	1.06 0	4.02-1
19	8.10 0	7.45 0	6.00 0	4.09 0	2.45 0	1.84 0	9.52-1	3.26-1
20	8.14 0	7.45 0	5.97 0	3.98 0	2.32 0	1.71 0	8.46-1	2.62-1
21	8.18 0	7.48 0	5.91 0	3.90 0	2.21 0	1.59 0	7.52-1	2.06-1
22	8.21 0	7.46 0	5.85 0	3.79 0	2.09 0	1.48 0	6.63-1	1.67-1
23	8.20 0	7.45 0	5.76 0	3.71 0	1.97 0	1.36 0	5.79-1	1.27-1
24	8.22 0	7.42 0	5.69 0	3.60 0	1.86 0	1.26 0	5.07-1	1.05-1
25	8.18 0	7.38 0	5.59 0	3.50 0	1.74 0	1.15 0	4.31-1	7.02-2
26	8.18 0	7.34 0	5.52 0	3.41 0	1.64 0	1.06 0	3.74-1	6.00-2
27	8.13 0	7.27 0	5.42 0	3.29 0	1.53 0	9.62-1	3.04-1	2.79-2
28	8.10 0	7.22 0	5.33 0	3.20 0	1.44 0	8.82-1	2.60-1	2.70-2
29	8.06 0	7.13 0	5.23 0	3.08 0	1.33 0	7.85-1	1.94-1	5.23-3
30	8.00 0	7.07 0	5.13 0	2.97 0	1.25 0	7.17-1	1.63-1	8.22-3
31	7.95 0	6.98 0	5.03 0	2.84 0	1.15 0	6.27-1	1.06-1	-3.25-4
32	7.87 0	6.90 0	4.92 0	2.74 0	1.07 0	5.69-1	8.82-2	1.06-3
33	7.81 0	6.81 0	4.82 0	2.61 0	9.78-1	4.91-1	4.69-2	1.31-4
34	7.73 0	6.72 0	4.71 0	2.51 0	9.07-1	4.42-1	4.13-2	-4.93-4
35	7.66 0	6.63 0	4.61 0	2.37 0	8.25-1	3.75-1	1.67-2	1.13-4
36	7.57 0	6.53 0	4.49 0	2.28 0	7.62-1	3.31-1	1.91-2	-4.40-5
37	7.49 0	6.43 0	4.37 0	2.15 0	6.87-1	2.74-1	5.81-3	5.39-5
38	7.40 0	6.33 0	4.26 0	2.06 0	6.31-1	2.37-1	1.06-2	5.91-4
39	7.31 0	6.20 0	4.13 0	1.94 0	5.64-1	1.90-1	2.26-3	3.47-4
40	7.21 0	6.10 0	4.01 0	1.84 0	5.15-1	1.64-1	5.65-3	2.31-4
41	7.12 0	5.98 0	3.88 0	1.74 0	4.57-1	1.28-1	2.81-4	9.60-5
42	7.02 0	5.87 0	3.78 0	1.64 0	4.15-1	1.14-1	1.85-3	-3.31-4
43	6.92 0	5.76 0	3.65 0	1.55 0	3.67-1	8.60-2	-3.06-4	-1.35-4
44	6.81 0	5.64 0	3.55 0	1.46 0	3.32-1	7.87-2	3.41-4	1.21-4
45	6.71 0	5.54 0	3.43 0	1.38 0	2.90-1	5.43-2	1.98-4	2.89-4
46	6.60 0	5.41 0	3.33 0	1.30 0	2.61-1	4.90-2	2.48-4	6.21-4
47	6.50 0	5.31 0	3.22 0	1.22 0	2.20-1	2.80-2	3.02-4	4.47-4
48	6.38 0	5.18 0	3.11 0	1.15 0	1.95-1	2.42-2	5.68-5	1.74-4
49	6.28 0	5.08 0	3.01 0	1.07 0	1.56-1	9.46-3	1.91-5	7.08-5
50	6.16 0	4.96 0	2.90 0	1.01 0	1.36-1	9.44-3	1.03-4	-8.31-5

Table I3. Continued

Index	Wavelength ( $\mu\text{m}$ )							
	0.40	0.44	0.55	0.75	1.04	1.24	1.65	2.20
51	6.06 0	4.85 0	2.80 0	9.33-1	1.02-1	1.53-3	1.77-4	8.52-5
52	5.94 0	4.74 0	2.70 0	8.73-1	8.71-2	4.21-3	3.73-4	3.33-4
53	5.84 0	4.64 0	2.60 0	8.03-1	6.17-2	4.33-4	2.08-4	2.87-4
54	5.72 0	4.52 0	2.51 0	7.49-1	5.20-2	2.33-3	-2.89-5	2.30-4
55	5.62 0	4.41 0	2.42 0	6.88-1	3.46-2	4.66-4	-1.92-4	3.67-5
56	5.50 0	4.29 0	2.33 0	6.38-1	3.00-2	7.83-4	-3.33-4	-1.40-4
57	5.40 0	4.18 0	2.24 0	5.86-1	1.80-2	1.77-4	-1.24-5	3.90-5
58	5.27 0	4.07 0	2.15 0	5.39-1	1.74-2	1.94-4	3.59-4	2.61-4
59	5.17 0	3.96 0	2.07 0	4.95-1	7.94-3	4.65-5	4.64-4	3.47-4
60	5.05 0	3.86 0	1.98 0	4.50-1	8.82-3	7.87-5	4.61-4	3.17-4
61	4.94 0	3.75 0	1.90 0	4.10-1	1.38-3	-3.40-4	-9.29-5	-1.44-4
62	4.82 0	3.65 0	1.81 0	3.72-1	2.20-3	-4.86-4	-6.56-4	-6.26-4
63	4.72 0	3.55 0	1.73 0	3.35-1	-1.51-3	-5.02-4	-7.22-4	-6.87-4
64	4.60 0	3.45 0	1.65 0	3.06-1	-3.06-4	-2.25-4	-5.99-4	-5.51-4
65	4.50 0	3.36 0	1.58 0	2.72-1	-5.62-4	3.57-4	1.19-4	6.61-5
66	4.38 0	3.26 0	1.50 0	2.52-1	5.60-4	7.91-4	7.96-4	6.51-4
67	4.28 0	3.16 0	1.43 0	2.19-1	6.30-4	7.30-4	7.75-4	5.75-4
68	4.16 0	3.06 0	1.36 0	2.03-1	3.35-4	2.78-4	4.97-4	2.47-4
69	4.06 0	2.97 0	1.29 0	1.72-1	-5.17-4	-3.38-4	-2.92-4	-5.01-4
70	3.95 0	2.87 0	1.23 0	1.57-1	-1.32-3	-9.14-4	-1.01-3	-1.15-3
71	3.84 0	2.78 0	1.16 0	1.30-1	-1.44-3	-5.59-4	-7.96-4	-8.96-4
72	3.74 0	2.69 0	1.10 0	1.18-1	-8.79-4	9.31-5	-3.37-4	-3.65-4
73	3.64 0	2.60 0	1.03 0	9.46-2	-1.23-4	9.16-4	5.59-4	5.11-4
74	3.54 0	2.52 0	9.81-1	8.65-2	8.63-4	1.61-3	1.29-3	1.22-3
75	3.43 0	2.43 0	9.20-1	6.55-2	8.27-4	1.22-3	1.03-3	9.30-4
76	3.34 0	2.35 0	8.71-1	5.98-2	4.92-4	5.23-4	5.00-4	3.70-4
77	3.23 0	2.27 0	8.17-1	4.16-2	4.53-5	-1.90-4	-2.23-4	-3.38-4
78	3.14 0	2.19 0	7.71-1	3.90-2	-4.63-4	-7.71-4	-7.50-4	-8.28-4
79	3.04 0	2.11 0	7.24-1	2.48-2	7.25-5	-2.16-4	-2.82-4	-3.05-4
80	2.95 0	2.03 0	6.82-1	2.51-2	7.34-4	5.61-4	4.06-4	4.41-4
81	2.85 0	1.95 0	6.37-1	1.42-2	1.32-3	1.15-3	1.01-3	1.09-3
82	2.77 0	1.88 0	5.97-1	1.51-2	1.81-3	1.61-3	1.41-3	1.51-3
83	2.67 0	1.80 0	5.53-1	6.37-3	1.42-3	9.76-4	9.05-4	1.00-3
84	2.59 0	1.73 0	5.17-1	7.03-3	9.38-4	3.10-4	3.15-4	3.79-4
85	2.50 0	1.66 0	4.75-1	1.39-3	8.23-4	-9.01-5	-2.57-6	4.32-5
86	2.42 0	1.60 0	4.44-1	2.90-3	7.21-4	-2.29-4	-4.11-5	-3.10-5
87	2.33 0	1.53 0	4.08-1	3.38-4	1.27-3	3.04-4	4.38-4	4.71-4
88	2.26 0	1.48 0	3.81-1	2.32-3	1.61-3	8.56-4	9.60-4	9.70-4
89	2.17 0	1.41 0	3.48-1	6.67-4	1.40-3	8.20-4	8.21-4	8.78-4
90	2.10 0	1.36 0	3.23-1	1.44-3	9.38-4	6.13-4	5.02-4	5.52-4
91	2.01 0	1.30 0	2.92-1	2.04-4	2.96-4	8.83-5	-3.03-5	4.15-6
92	1.95 0	1.24 0	2.69-1	3.64-4	-1.49-4	-2.45-4	-4.13-4	-3.87-4
93	1.87 0	1.18 0	2.40-1	4.68-4	2.02-4	9.25-5	1.16-5	-2.00-5
94	1.81 0	1.13 0	2.21-1	9.54-4	7.39-4	6.33-4	5.97-4	5.30-4
95	1.73 0	1.07 0	1.93-1	1.27-3	9.67-4	9.09-4	8.67-4	7.90-4
96	1.67 0	1.02 0	1.78-1	7.86-4	8.54-4	8.95-4	8.62-4	7.44-4
97	1.60 0	9.70-1	1.52-1	1.13-4	-1.96-4	8.34-5	-8.17-5	-1.90-4
98	1.54 0	9.24-1	1.40-1	-1.41-3	-1.36-3	-8.88-4	-1.13-3	-1.22-3
99	1.47 0	8.75-1	1.18-1	-1.42-3	-1.70-3	-9.76-4	-1.28-3	-1.43-3
100	1.42 0	8.34-1	1.09-1	-1.54-3	-1.53-3	-7.46-4	-1.10-3	-1.20-3

Table I3. Concluded

Index	Wavelength ( $\mu\text{m}$ )							
	0.40	0.44	0.55	0.75	1.04	1.24	1.65	2.20
101	1.35 0	7.89-1	9.12-2	-4.13-4	-4.51-4	4.09-4	1.45-4	-1.48-5
102	1.31 0	7.52-1	8.43-2	6.00-4	8.38-4	1.54-3	1.32-3	1.15-3
103	1.24 0	7.08-1	6.74-2	3.84-4	7.30-4	1.38-3	1.24-3	1.07-3
104	1.19 0	6.71-1	6.04-2	-2.05-4	3.18-4	7.53-4	6.80-4	4.63-4
105	1.13 0	6.28-1	4.43-2	-1.64-3	-1.03-3	-5.96-4	-7.24-4	-9.43-4
106	1.09 0	5.92-1	3.90-2	-2.88-3	-2.22-3	-1.91-3	-2.01-3	-2.21-3
107	1.03 0	5.53-1	2.68-2	-2.34-3	-1.76-3	-1.42-3	-1.57-3	-1.80-3
108	9.90-1	5.22-1	2.62-2	-1.40-3	-7.58-4	-5.26-4	-6.54-4	-8.41-4
109	9.39-1	4.86-1	1.74-2	5.36-4	8.47-4	9.90-4	9.43-4	7.57-4
110	8.99-1	4.59-1	1.89-2	2.08-3	2.41-3	2.30-3	2.29-3	2.11-3
111	8.49-1	4.24-1	1.04-2	2.01-3	2.04-3	1.67-3	1.76-3	1.64-3
112	8.10-1	3.97-1	1.04-2	1.53-3	1.33-3	6.99-4	8.08-4	6.67-4
113	7.62-1	3.65-1	3.21-3	3.02-4	3.43-4	-6.00-4	-4.87-4	-6.02-4
114	7.26-1	3.41-1	3.14-3	-1.76-4	-5.52-4	-1.51-3	-1.42-3	-1.53-3
115	6.83-1	3.13-1	-1.69-4	1.79-4	5.83-4	-6.03-4	-5.50-4	-6.68-4
116	6.51-1	2.92-1	1.46-3	1.55-3	1.62-3	6.81-4	6.88-4	5.93-4
117	6.11-1	2.67-1	6.49-5	2.08-3	2.84-3	1.76-3	1.77-3	1.71-3
118	5.81-1	2.48-1	9.71-4	2.70-3	3.35-3	2.54-3	2.48-3	2.44-3
119	5.41-1	2.22-1	-8.60-4	1.70-3	2.47-3	1.61-3	1.57-3	1.59-3
120	5.13-1	2.04-1	-1.67-3	4.55-4	1.33-3	6.12-4	5.10-4	5.36-4
121	4.76-1	1.81-1	-2.21-3	1.41-4	6.82-4	8.67-5	-5.38-5	-2.18-5
122	4.51-1	1.67-1	-2.23-3	-3.74-4	5.00-4	3.84-6	-1.74-4	-1.67-4
123	4.18-1	1.47-1	-9.60-4	7.76-4	1.15-3	9.73-4	6.85-4	6.57-4
124	3.96-1	1.36-1	-3.00-4	1.14-3	1.86-3	1.87-3	1.56-3	1.50-3
125	3.65-1	1.18-1	2.01-5	1.18-3	1.44-3	1.82-3	1.38-3	1.33-3
126	3.43-1	1.08-1	-8.82-4	3.92-4	7.00-4	1.27-3	8.58-4	8.15-4
127	3.14-1	9.15-2	-1.38-3	-4.84-4	-4.07-4	4.20-4	-4.99-5	-6.99-5
128	2.94-1	8.25-2	-2.54-3	-1.07-3	-1.22-3	-3.44-4	-7.01-4	-7.18-4
129	2.69-1	6.94-2	-1.48-3	-5.47-4	-6.90-4	2.53-4	-4.74-5	-8.04-5
130	2.52-1	6.35-2	-1.27-3	5.75-4	2.85-4	1.07-3	9.08-4	8.01-4
131	2.30-1	5.21-2	-1.52-4	1.02-3	7.44-4	1.45-3	1.37-3	1.23-3
132	2.14-1	4.67-2	-1.00-3	1.23-3	9.73-4	1.43-3	1.39-3	1.18-3
133	1.92-1	3.52-2	-1.76-3	-1.58-4	-4.35-4	-8.72-5	-1.09-4	-3.38-4
134	1.76-1	2.95-2	-4.21-3	-1.66-3	-1.88-3	-1.70-3	-1.77-3	-1.97-3
135	1.58-1	2.07-2	-4.23-3	-1.98-3	-2.11-3	-2.02-3	-2.05-3	-2.29-3
136	1.45-1	1.78-2	-4.61-3	-1.74-3	-1.74-3	-1.68-3	-1.77-3	-1.94-3
137	1.31-1	1.27-2	-2.92-3	6.54-5	1.98-4	1.49-4	1.82-4	-2.67-5
138	1.21-1	1.20-2	-1.48-3	1.76-3	2.08-3	2.04-3	2.04-3	1.82-3
139	1.07-1	6.39-3	-1.90-3	1.78-3	2.03-3	1.83-3	1.94-3	1.71-3
140	9.62-2	3.97-3	-2.76-3	9.05-4	1.20-3	9.90-4	1.05-3	8.05-4

# Appendix J

## SRA Volcanic Ash Aerosol Model

Table J1. Optical Parameters

Wavelength ( $\mu\text{m}$ )	Extinction Cross Section ( $\text{m}^2$ )	Asymmetry Factor	Single Scattering Albedo	180 Degree Backscatter ( $\text{m}^2/\text{sr}$ )	Refractive Indices
0.40	1.03-13	0.705	0.934	3.17-15	1.50 -8.00-3
0.44	9.98-14	0.703	0.941	2.88-15	1.50 -8.00-3
0.55	9.02-14	0.698	0.947	2.21-15	1.50 -8.00-3
0.75	7.14-14	0.684	0.954	1.40-15	1.50 -8.00-3
1.04	4.91-14	0.658	0.953	8.63-16	1.50 -8.00-3
1.24	3.78-14	0.637	0.952	6.61-16	1.50 -8.00-3
1.65	2.20-14	0.593	0.941	4.21-16	1.49 -8.00-3
2.20	1.05-14	0.532	0.928	2.50-16	1.46 -8.00-3

Table J2. Phase Functions

Scatter Angle (deg)	Wavelength ( $\mu\text{m}$ )							
	0.40	0.44	0.55	0.75	1.04	1.24	1.65	2.20
0	2.01 0	1.80 0	1.44 0	1.10 0	8.53-1	7.41-1	5.93-1	4.71-1
1	2.00 0	1.79 0	1.43 0	1.10 0	8.51-1	7.40-1	5.93-1	4.71-1
2	1.95 0	1.76 0	1.41 0	1.09 0	8.47-1	7.38-1	5.91-1	4.70-1
4	1.79 0	1.63 0	1.35 0	1.06 0	8.31-1	7.26-1	5.85-1	4.66-1
6	1.58 0	1.47 0	1.25 0	1.01 0	8.06-1	7.08-1	5.74-1	4.59-1
8	1.37 0	1.29 0	1.14 0	9.47-1	7.72-1	6.84-1	5.59-1	4.50-1
10	1.17 0	1.13 0	1.02 0	8.79-1	7.33-1	6.55-1	5.41-1	4.40-1
15	7.88-1	7.83-1	7.60-1	7.03-1	6.20-1	5.69-1	4.86-1	4.05-1
20	5.42-1	5.50-1	5.56-1	5.44-1	5.06-1	4.77-1	4.23-1	3.63-1
40	1.52-1	1.56-1	1.65-1	1.78-1	1.91-1	1.95-1	1.99-1	1.96-1
60	5.37-2	5.47-2	5.75-2	6.31-2	7.13-2	7.66-2	8.51-2	9.26-2
80	2.35-2	2.38-2	2.47-2	2.69-2	3.07-2	3.36-2	3.91-2	4.51-2
100	1.32-2	1.33-2	1.37-2	1.48-2	1.68-2	1.85-2	2.18-2	2.65-2
120	1.02-2	1.03-2	1.06-2	1.13-2	1.26-2	1.38-2	1.65-2	2.11-2
140	1.28-2	1.27-2	1.25-2	1.24-2	1.29-2	1.37-2	1.63-2	2.15-2
150	1.70-2	1.65-2	1.53-2	1.40-2	1.38-2	1.44-2	1.70-2	2.26-2
160	2.11-2	1.99-2	1.73-2	1.48-2	1.44-2	1.52-2	1.81-2	2.39-2
170	2.17-2	2.06-2	1.86-2	1.66-2	1.62-2	1.68-2	1.94-2	2.51-2
175	2.78-2	2.62-2	2.28-2	1.91-2	1.77-2	1.79-2	2.01-2	2.55-2
180	3.29-2	3.07-2	2.59-2	2.06-2	1.84-2	1.84-2	2.03-2	2.57-2

Table J3. Legendre Coefficients of Phase Functions

Index	Wavelength ( $\mu\text{m}$ )							
	0.40	0.44	0.55	0.75	1.04	1.24	1.65	2.20
0	1.00 0	1.00 0	1.00 0	1.00 0	1.00 0	1.00 0	1.00 0	1.00 0
1	2.11 0	2.11 0	2.09 0	2.05 0	1.97 0	1.91 0	1.78 0	1.60 0
2	2.66 0	2.62 0	2.52 0	2.36 0	2.13 0	1.98 0	1.73 0	1.46 0
3	2.50 0	2.44 0	2.28 0	2.03 0	1.71 0	1.51 0	1.19 0	8.72-1
4	2.35 0	2.25 0	2.00 0	1.65 0	1.27 0	1.06 0	7.54-1	4.88-1
5	2.04 0	1.91 0	1.62 0	1.24 0	8.73-1	6.88-1	4.37-1	2.47-1
6	1.79 0	1.63 0	1.31 0	9.21-1	5.91-1	4.40-1	2.53-1	1.27-1
7	1.55 0	1.38 0	1.04 0	6.73-1	3.90-1	2.71-1	1.38-1	6.22-2
8	1.33 0	1.16 0	8.30-1	4.93-1	2.62-1	1.72-1	8.02-2	3.27-2
9	1.15 0	9.77-1	6.61-1	3.56-1	1.69-1	1.02-1	4.31-2	1.59-2
10	9.81-1	8.21-1	5.32-1	2.67-1	1.18-1	6.76-2	2.64-2	9.08-3
11	8.38-1	6.85-1	4.17-1	1.89-1	7.32-2	3.88-2	1.32-2	4.02-3
12	7.25-1	5.84-1	3.44-1	1.47-1	5.47-2	2.75-2	8.15-3	1.80-3
13	6.08-1	4.78-1	2.64-1	1.01-1	3.20-2	1.48-2	3.49-3	4.05-4
14	5.35-1	4.17-1	2.25-1	8.31-2	2.45-2	1.15-2	2.48-3	1.07-4
15	4.40-1	3.34-1	1.69-1	5.52-2	1.37-2	6.28-3	1.50-3	4.77-4
16	3.95-1	2.98-1	1.49-1	4.76-2	1.25-2	6.02-3	1.97-3	1.17-3
17	3.19-1	2.35-1	1.09-1	3.10-2	6.90-3	3.14-3	1.11-3	7.65-4
18	2.89-1	2.13-1	9.74-2	2.79-2	6.05-3	2.54-3	5.72-4	2.46-4
19	2.31-1	1.66-1	7.04-2	1.73-2	2.71-3	5.30-4	-4.62-4	-6.36-4
20	2.10-1	1.51-1	6.40-2	1.47-2	2.17-3	2.49-6	-1.04-3	-1.33-3
21	1.69-1	1.19-1	4.73-2	9.95-3	1.30-3	1.84-4	-2.85-4	-3.90-4
22	1.55-1	1.09-1	4.45-2	9.53-3	2.16-3	1.26-3	8.77-4	8.42-4
23	1.26-1	8.53-2	3.32-2	7.11-3	2.06-3	1.59-3	1.46-3	1.48-3
24	1.15-1	7.70-2	3.06-2	6.32-3	2.06-3	1.63-3	1.58-3	1.76-3
25	9.20-2	5.91-2	2.15-2	3.11-3	6.68-5	-2.03-4	-2.77-4	-1.90-4
26	8.16-2	5.15-2	1.79-2	1.09-3	-1.79-3	-2.13-3	-2.34-3	-2.41-3
27	6.60-2	4.03-2	1.27-2	-1.32-4	-2.24-3	-2.49-3	-2.63-3	-2.62-3
28	5.91-2	3.65-2	1.15-2	2.16-4	-1.64-3	-1.88-3	-2.09-3	-2.28-3
29	5.01-2	3.13-2	1.04-2	1.98-3	8.43-4	7.91-4	7.65-4	7.30-4
30	4.64-2	3.01-2	1.13-2	4.08-3	3.34-3	3.43-3	3.65-3	3.85-3
31	3.86-2	2.51-2	8.98-3	3.47-3	3.04-3	3.14-3	3.31-3	3.35-3
32	3.34-2	2.14-2	6.95-3	2.00-3	1.52-3	1.58-3	1.77-3	1.99-3
33	2.57-2	1.54-2	2.81-3	-1.28-3	-1.90-3	-2.00-3	-2.01-3	-1.91-3
34	2.03-2	1.10-2	-2.27-4	-4.05-3	-4.92-3	-5.18-3	-5.49-3	-5.74-3
35	1.76-2	9.59-3	-7.73-5	-3.14-3	-3.85-3	-4.06-3	-4.22-3	-4.19-3
36	1.74-2	1.01-2	1.68-3	-8.53-4	-1.33-3	-1.43-3	-1.57-3	-1.71-3
37	1.78-2	1.15-2	4.53-3	2.77-3	2.71-3	2.80-3	2.89-3	2.81-3
38	1.87-2	1.32-2	7.08-3	5.74-3	5.98-3	6.26-3	6.65-3	6.97-3
39	1.52-2	1.04-2	5.20-3	4.06-3	4.20-3	4.35-3	4.48-3	4.40-3
40	1.16-2	7.25-3	2.39-3	1.12-3	9.60-4	9.55-4	9.27-4	9.08-4
41	7.11-3	3.25-3	-1.06-3	-2.44-3	-2.93-3	-3.12-3	-3.36-3	-3.41-3
42	4.10-3	5.33-4	-3.43-3	-4.88-3	-5.61-3	-5.98-3	-6.53-3	-6.99-3
43	5.15-3	2.02-3	-1.25-3	-2.37-3	-2.87-3	-3.07-3	-3.31-3	-3.36-3
44	7.62-3	4.80-3	2.05-3	1.30-3	1.18-3	1.15-3	1.15-3	1.15-3
45	9.21-3	6.77-3	4.67-3	4.29-3	4.46-3	4.56-3	4.67-3	4.56-3
46	1.03-2	8.08-3	6.26-3	6.00-3	6.29-3	6.49-3	6.81-3	7.07-3
47	6.97-3	5.01-3	3.40-3	2.99-3	2.97-3	2.95-3	2.86-3	2.68-3
48	3.54-3	1.72-3	6.61-5	-6.19-4	-1.04-3	-1.28-3	-1.69-3	-2.07-3
49	1.64-3	2.95-5	-1.51-3	-2.28-3	-2.84-3	-3.14-3	-3.54-3	-3.72-3
50	1.14-3	-3.27-4	-1.72-3	-2.43-3	-2.94-3	-3.23-3	-3.68-3	-4.08-3

Table J3. Concluded

Index	Wavelength ( $\mu\text{m}$ )							
	0.40	0.44	0.55	0.75	1.04	1.24	1.65	2.20
51	3.40-3	2.14-3	1.09-3	7.04-4	5.93-4	5.52-4	5.07-4	4.74-4
52	5.82-3	4.69-3	3.90-3	3.82-3	4.11-3	4.31-3	4.66-3	5.03-3
53	4.95-3	3.91-3	3.29-3	3.29-3	3.53-3	3.68-3	3.88-3	3.93-3
54	3.13-3	2.12-3	1.51-3	1.37-3	1.39-3	1.42-3	1.50-3	1.62-3
55	1.02-4	-8.49-4	-1.49-3	-1.86-3	-2.21-3	-2.40-3	-2.66-3	-2.74-3
56	-2.12-3	-2.98-3	-3.62-3	-4.13-3	-4.72-3	-5.11-3	-5.76-3	-6.35-3
57	-9.49-5	-7.61-4	-1.21-3	-1.44-3	-1.71-3	-1.88-3	-2.17-3	-2.34-3
58	2.90-3	2.43-3	2.19-3	2.36-3	2.57-3	2.68-3	2.77-3	2.82-3
59	4.41-3	4.11-3	4.05-3	4.55-3	5.15-3	5.46-3	5.83-3	5.87-3
60	4.53-3	4.28-3	4.24-3	4.79-3	5.54-3	6.01-3	6.79-3	7.48-3
61	-4.49-4	-7.60-4	-9.98-4	-8.51-4	-6.26-4	-4.69-4	-1.54-4	1.02-4
62	-5.96-3	-6.37-3	-6.81-3	-7.12-3	-7.51-3	-7.73-3	-7.96-3	-8.16-3
63	-6.99-3	-7.42-3	-7.89-3	-8.40-3	-9.02-3	-9.34-3	-9.59-3	-9.45-3
64	-5.98-3	-6.34-3	-6.60-3	-6.91-3	-7.42-3	-7.78-3	-8.28-3	-8.82-3
65	6.00-4	4.24-4	5.89-4	9.22-4	1.21-3	1.30-3	1.42-3	1.39-3
66	7.10-3	7.09-3	7.61-3	8.55-3	9.63-3	1.02-2	1.11-2	1.17-2
67	6.51-3	6.56-3	7.11-3	8.15-3	9.32-3	9.89-3	1.06-2	1.07-2
68	3.29-3	3.28-3	3.55-3	4.21-3	5.04-3	5.52-3	6.26-3	6.95-3
69	-4.71-3	-4.89-3	-5.13-3	-5.28-3	-5.39-3	-5.43-3	-5.38-3	-5.08-3
70	-1.21-2	-1.24-2	-1.30-2	-1.38-2	-1.48-2	-1.53-2	-1.62-2	-1.68-2
71	-9.65-3	-9.92-3	-1.06-2	-1.13-2	-1.22-2	-1.26-2	-1.30-2	-1.28-2
72	-4.48-3	-4.60-3	-4.87-3	-5.07-3	-5.38-3	-5.56-3	-5.87-3	-6.14-3
73	4.45-3	4.55-3	4.80-3	5.43-3	6.07-3	6.40-3	6.73-3	6.70-3
74	1.20-2	1.22-2	1.28-2	1.40-2	1.54-2	1.62-2	1.73-2	1.83-2
75	8.46-3	8.66-3	9.14-3	1.00-2	1.10-2	1.15-2	1.19-2	1.18-2
76	2.33-3	2.35-3	2.39-3	2.51-3	2.61-3	2.68-3	2.76-3	2.80-3
77	-5.42-3	-5.60-3	-6.08-3	-6.81-3	-7.70-3	-8.11-3	-8.61-3	-8.65-3
78	-1.12-2	-1.14-2	-1.22-2	-1.34-2	-1.49-2	-1.58-2	-1.71-2	-1.81-2
79	-5.69-3	-5.89-3	-6.48-3	-7.34-3	-8.28-3	-8.70-3	-9.16-3	-9.12-3

# Appendix K

## Pre-Eruption Stratospheric Aerosol Model

Table K1. Optical Parameters

Wavelength ( $\mu\text{m}$ )	Extinction Cross Section ( $\text{m}^2$ )	Asymmetry Factor	Single Scattering Albedo	180 Degree Backscatter ( $\text{m}^2/\text{sr}$ )	Refractive Indices	
0.40	4.77-14	0.694	1.000	7.01-16	1.44	-1.00-8
0.44	4.09-14	0.678	1.000	6.11-16	1.44	-1.00-8
0.55	2.59-14	0.634	1.000	4.31-16	1.43	-1.00-8
0.75	1.27-14	0.544	1.000	2.99-16	1.43	-7.36-8
1.04	4.99-15	0.424	1.000	1.85-16	1.42	-1.37-6
1.24	2.79-15	0.354	1.000	1.31-16	1.41	-7.88-6
1.65	1.07-15	0.248	0.987	6.75-17	1.40	-3.15-4
2.20	3.81-16	0.159	0.869	2.67-17	1.37	-1.69-3

Table K2. Phase Functions

Scatter Angle (deg)	Wavelength ( $\mu\text{m}$ )							
	0.40	0.44	0.55	0.75	1.04	1.24	1.65	2.20
0	8.79-1	7.99-1	6.40-1	4.58-1	3.25-1	2.73-1	2.12-1	1.73-1
1	8.77-1	7.98-1	6.39-1	4.58-1	3.25-1	2.73-1	2.12-1	1.73-1
2	8.74-1	7.95-1	6.38-1	4.57-1	3.25-1	2.72-1	2.12-1	1.73-1
4	8.60-1	7.84-1	6.31-1	4.54-1	3.23-1	2.71-1	2.11-1	1.73-1
6	8.38-1	7.65-1	6.20-1	4.49-1	3.21-1	2.70-1	2.10-1	1.72-1
8	8.08-1	7.41-1	6.04-1	4.41-1	3.17-1	2.67-1	2.09-1	1.71-1
10	7.72-1	7.11-1	5.85-1	4.32-1	3.13-1	2.64-1	2.07-1	1.70-1
15	6.62-1	6.20-1	5.26-1	4.02-1	2.98-1	2.54-1	2.01-1	1.65-1
20	5.44-1	5.18-1	4.56-1	3.64-1	2.78-1	2.40-1	1.92-1	1.59-1
40	1.96-1	2.01-1	2.06-1	2.01-1	1.81-1	1.67-1	1.44-1	1.26-1
60	6.64-2	7.13-2	8.21-2	9.47-2	1.00-1	9.95-2	9.52-2	8.89-2
80	2.63-2	2.86-2	3.47-2	4.49-2	5.44-2	5.82-2	6.21-2	6.35-2
100	1.36-2	1.48-2	1.81-2	2.54-2	3.51-2	4.06-2	4.84-2	5.43-2
120	9.93-3	1.06-2	1.29-2	1.95-2	3.03-2	3.73-2	4.84-2	5.81-2
140	1.01-2	1.05-2	1.26-2	1.95-2	3.20-2	4.05-2	5.48-2	6.80-2
150	1.09-2	1.13-2	1.34-2	2.06-2	3.37-2	4.28-2	5.83-2	7.30-2
160	1.18-2	1.22-2	1.46-2	2.19-2	3.54-2	4.48-2	6.12-2	7.71-2
170	1.34-2	1.38-2	1.60-2	2.30-2	3.66-2	4.62-2	6.32-2	7.97-2
175	1.43-2	1.46-2	1.65-2	2.34-2	3.69-2	4.65-2	6.37-2	8.04-2
180	1.47-2	1.49-2	1.67-2	2.35-2	3.70-2	4.67-2	6.38-2	8.06-2

Table K3. Legendre Coefficients of Phase Functions

Index	Wavelength ( $\mu\text{m}$ )							
	0.40	0.44	0.55	0.75	1.04	1.24	1.65	2.20
0	1.00 0	1.00 0	1.00 0	1.00 0	1.00 0	1.00 0	1.00 0	1.00 0
1	2.08 0	2.04 0	1.90 0	1.63 0	1.27 0	1.06 0	7.45-1	4.77-1
2	2.30 0	2.18 0	1.89 0	1.46 0	1.07 0	8.94-1	6.95-1	5.81-1
3	1.87 0	1.71 0	1.33 0	8.46-1	4.70-1	3.29-1	1.81-1	1.03-1
4	1.38 0	1.21 0	8.52-1	4.49-1	1.89-1	1.07-1	3.93-2	1.43-2
5	9.17-1	7.70-1	4.88-1	2.09-1	6.33-2	2.75-2	7.00-3	1.63-3
6	5.92-1	4.79-1	2.76-1	9.76-2	2.04-2	6.38-3	9.73-4	8.74-5
7	3.65-1	2.83-1	1.46-1	3.99-2	5.00-3	1.20-3	1.25-4	2.60-5
8	2.25-1	1.69-1	7.97-2	1.65-2	1.13-3	2.32-4	4.63-5	4.75-5
9	1.33-1	9.50-2	3.89-2	4.82-3	2.47-4	7.87-5	2.14-5	1.69-5
10	8.19-2	5.67-2	2.03-2	1.67-3	1.12-4	1.02-4	7.74-5	8.92-5
11	4.49-2	2.88-2	7.86-3	3.72-4	1.25-5	1.99-5	-5.97-6	-9.25-6
12	2.81-2	1.70-2	3.73-3	-2.29-6	-7.08-5	-6.59-5	-6.35-5	-6.59-5
13	1.27-2	6.41-3	6.84-4	-9.27-5	-8.19-5	-6.55-5	-2.21-5	-1.49-6
14	8.01-3	3.74-3	2.06-4	-1.01-4	-7.45-5	-7.78-5	-5.59-5	-5.54-5
15	2.11-3	5.87-4	6.86-5	7.81-6	2.46-5	1.91-5	2.35-5	2.37-5
16	1.72-3	3.95-4	1.08-4	1.32-4	1.22-4	1.36-4	1.18-4	1.27-4
17	2.15-4	4.31-5	9.38-5	1.14-4	7.11-5	7.52-5	1.59-5	-1.98-6
18	7.11-5	2.52-5	1.44-6	5.14-5	1.78-5	3.45-5	9.85-6	1.45-5
19	4.39-6	2.51-5	-1.14-4	-7.82-5	-9.06-5	-6.86-5	-4.30-5	-3.01-5
20	-6.63-5	-1.00-4	-1.42-4	-1.97-4	-2.05-4	-2.11-4	-1.69-4	-1.95-4
21	-2.50-5	-5.94-5	-3.89-5	-8.87-5	-6.19-5	-6.63-5	5.18-6	-1.06-5
22	6.53-5	7.71-5	8.22-5	7.71-5	1.01-4	8.25-5	1.28-4	8.36-5
23	1.20-4	1.23-4	1.52-4	1.77-4	1.75-4	1.29-4	1.08-4	4.13-5
24	1.18-4	1.35-4	1.56-4	2.39-4	2.62-4	2.50-4	2.48-4	2.49-4
25	-5.70-5	-3.84-5	-5.39-5	1.62-5	6.66-6	-1.02-5	-3.33-5	-9.46-6
26	-2.74-4	-2.89-4	-2.84-4	-2.80-4	-2.86-4	-2.93-4	-3.12-4	-2.60-4
27	-3.18-4	-3.42-4	-3.11-4	-3.36-4	-2.75-4	-2.40-4	-1.87-4	-8.09-5
28	-2.24-4	-2.54-4	-2.30-4	-3.05-4	-3.21-4	-3.22-4	-3.39-4	-3.20-4
29	8.15-5	6.05-5	1.03-4	6.65-5	4.46-5	5.46-5	4.65-5	3.74-5
30	3.82-4	4.01-4	4.34-4	4.79-4	4.87-4	5.15-4	5.34-4	5.10-4
31	3.72-4	4.04-4	4.00-4	4.45-4	3.68-4	3.31-4	2.52-4	1.42-4
32	1.70-4	2.02-4	1.89-4	2.58-4	2.41-4	2.46-4	2.54-4	2.49-4
33	-2.49-4	-2.27-4	-2.75-4	-2.48-4	-2.33-4	-2.04-4	-1.60-4	-9.66-5
34	-6.08-4	-6.23-4	-6.68-4	-7.20-4	-7.42-4	-7.42-4	-7.46-4	-6.95-4
35	-5.10-4	-5.27-4	-5.27-4	-5.55-4	-4.69-4	-3.99-4	-3.09-4	-1.68-4
36	-1.83-4	-2.00-4	-1.79-4	-2.46-4	-2.31-4	-2.27-4	-2.53-4	-2.24-4
37	3.22-4	3.22-4	3.78-4	3.35-4	3.22-4	2.93-4	2.01-4	1.31-4
38	7.20-4	7.46-4	8.06-4	8.43-4	9.16-4	9.32-4	9.15-4	8.81-4
39	5.31-4	5.51-4	5.49-4	5.36-4	4.84-4	4.20-4	3.01-4	1.56-4
40	1.18-4	1.32-4	8.39-5	9.08-5	1.04-4	9.27-5	8.96-5	4.36-5
41	-3.70-4	-3.73-4	-4.57-4	-4.48-4	-3.92-4	-3.58-4	-2.61-4	-1.95-4
42	-6.88-4	-7.02-4	-8.07-4	-8.71-4	-9.20-4	-9.44-4	-9.37-4	-9.35-4
43	-3.77-4	-3.76-4	-4.15-4	-4.21-4	-3.82-4	-3.42-4	-2.52-4	-1.51-4
44	1.28-4	1.44-4	1.59-4	1.67-4	1.55-4	1.54-4	1.49-4	1.72-4
45	5.50-4	5.80-4	6.23-4	6.08-4	5.19-4	4.60-4	3.32-4	2.29-4
46	7.66-4	7.85-4	8.46-4	9.01-4	9.18-4	9.38-4	9.23-4	9.16-4
47	3.91-4	3.82-4	3.65-4	3.42-4	2.85-4	2.58-4	1.87-4	1.01-4
48	-8.83-5	-1.41-4	-2.06-4	-2.72-4	-3.15-4	-3.21-4	-3.37-4	-3.78-4
49	-3.24-4	-3.92-4	-4.70-4	-5.03-4	-4.47-4	-3.97-4	-2.87-4	-2.20-4
50	-3.17-4	-3.83-4	-4.49-4	-5.26-4	-5.65-4	-5.89-4	-5.86-4	-6.17-4



Table K3. Concluded

Index	Wavelength ( $\mu\text{m}$ )							
	0.40	0.44	0.55	0.75	1.04	1.24	1.65	2.20
51	9.47-5	5.68-5	7.00-5	6.08-5	5.18-5	3.15-5	2.88-5	1.07-5
52	5.08-4	5.05-4	5.76-4	6.40-4	6.77-4	6.79-4	7.02-4	7.07-4
53	4.55-4	4.58-4	5.19-4	5.33-4	4.53-4	3.98-4	2.93-4	2.08-4
54	1.74-4	1.83-4	2.01-4	2.31-4	2.22-4	2.33-4	2.41-4	2.63-4
55	-2.56-4	-2.71-4	-3.22-4	-3.33-4	-3.26-4	-2.73-4	-2.03-4	-1.12-4
56	-5.36-4	-5.61-4	-6.75-4	-7.71-4	-8.62-4	-8.84-4	-9.03-4	-8.94-4
57	-1.92-4	-1.96-4	-2.75-4	-2.99-4	-2.79-4	-2.54-4	-1.84-4	-1.07-4
58	3.30-4	3.54-4	3.37-4	3.58-4	3.74-4	3.40-4	3.40-4	3.41-4
59	6.44-4	6.92-4	7.26-4	7.53-4	6.99-4	5.76-4	4.35-4	2.95-4
60	6.50-4	6.98-4	7.89-4	9.22-4	1.05-3	1.04-3	1.08-3	1.10-3
61	-9.27-5	-7.70-5	-4.44-5	6.29-6	6.78-5	3.12-5	4.39-5	3.42-5
62	-9.16-4	-9.48-4	-9.87-4	-1.03-3	-1.01-3	-1.03-3	-9.84-4	-9.69-4
63	-1.12-3	-1.17-3	-1.22-3	-1.22-3	-1.06-3	-9.20-4	-6.61-4	-4.44-4
64	-8.71-4	-9.11-4	-9.73-4	-1.09-3	-1.18-3	-1.17-3	-1.18-3	-1.20-3
65	1.74-4	1.86-4	2.19-4	1.93-4	1.27-4	1.43-4	1.04-4	3.64-5
66	1.17-3	1.24-3	1.38-3	1.49-3	1.51-3	1.56-3	1.55-3	1.50-3
67	1.18-3	1.25-3	1.38-3	1.40-3	1.21-3	1.09-3	7.95-4	4.94-4
68	6.04-4	6.56-4	7.59-4	8.86-4	9.60-4	1.01-3	1.01-3	1.00-3
69	-6.58-4	-6.72-4	-6.88-4	-6.38-4	-5.18-4	-4.34-4	-3.23-4	-2.04-4
70	-1.75-3	-1.82-3	-1.97-3	-2.08-3	-2.11-3	-2.11-3	-2.12-3	-2.07-3
71	-1.48-3	-1.55-3	-1.66-3	-1.63-3	-1.38-3	-1.21-3	-9.09-4	-5.63-4
72	-5.90-4	-6.29-4	-6.96-4	-7.51-4	-7.63-4	-7.78-4	-8.13-4	-7.69-4
73	8.17-4	8.41-4	8.86-4	8.78-4	7.65-4	6.62-4	4.46-4	3.12-4
74	1.91-3	1.98-3	2.14-3	2.31-3	2.38-3	2.40-3	2.35-3	2.35-3
75	1.43-3	1.49-3	1.57-3	1.54-3	1.31-3	1.15-3	8.21-4	5.30-4
76	3.79-4	3.88-4	3.93-4	3.84-4	3.52-4	3.60-4	3.50-4	3.24-4
77	-9.05-4	-9.49-4	-1.05-3	-1.08-3	-9.71-4	-8.41-4	-5.94-4	-4.10-4
78	-1.74-3	-1.82-3	-2.01-3	-2.22-3	-2.34-3	-2.36-3	-2.32-3	-2.35-3
79	-1.00-3	-1.04-3	-1.13-3	-1.14-3	-1.00-3	-8.81-4	-6.05-4	-4.12-4

# Appendix L

## 1.5-Month Post-Eruption Stratospheric Aerosol Model

Table L1. Optical Parameters

Wavelength ( $\mu\text{m}$ )	Extinction Cross Section ( $\text{m}^2$ )	Asymmetry Factor	Single Scattering Albedo	180 Degree Backscatter ( $\text{m}^2/\text{sr}$ )	Refractive Indices	
0.40	2.02-13	0.763	1.000	1.25-14	1.44	-1.00-8
0.44	2.04-13	0.757	1.000	1.18-14	1.44	-1.00-8
0.55	2.05-13	0.753	1.000	9.63-15	1.43	-1.00-8
0.75	2.16-13	0.723	1.000	1.17-14	1.43	-7.36-8
1.04	2.28-13	0.732	1.000	8.06-15	1.42	-1.37-6
1.24	2.34-13	0.742	1.000	6.40-15	1.41	-7.88-6
1.65	2.34-13	0.757	0.997	4.61-15	1.40	-3.15-4
2.20	2.06-13	0.782	0.987	2.40-15	1.37	-1.69-3

Table L2. Phase Functions

Scatter Angle (deg)	Wavelength ( $\mu\text{m}$ )							
	0.40	0.44	0.55	0.75	1.04	1.24	1.65	2.20
0	3.09 1	2.58 1	1.70 1	9.46 0	5.24 0	3.92 0	2.69 0	2.11 0
1	2.68 1	2.30 1	1.57 1	9.08 0	5.13 0	3.87 0	2.67 0	2.10 0
2	1.84 1	1.67 1	1.27 1	8.08 0	4.82 0	3.71 0	2.61 0	2.07 0
4	7.03 0	7.07 0	6.54 0	5.38 0	3.84 0	3.17 0	2.39 0	1.97 0
6	3.06 0	3.20 0	3.37 0	3.28 0	2.80 0	2.52 0	2.09 0	1.81 0
8	1.58 0	1.67 0	1.91 0	2.05 0	2.00 0	1.94 0	1.76 0	1.62 0
10	9.61-1	1.02 0	1.19 0	1.35 0	1.47 0	1.49 0	1.46 0	1.42 0
15	4.77-1	4.86-1	5.41-1	6.16-1	7.56-1	8.28-1	9.08-1	9.65-1
20	3.24-1	3.25-1	3.49-1	3.67-1	4.58-1	5.12-1	5.87-1	6.48-1
40	1.09-1	1.10-1	1.16-1	1.18-1	1.21-1	1.25-1	1.31-1	1.37-1
60	4.08-2	4.23-2	4.08-2	4.34-2	4.26-2	4.20-2	4.05-2	3.84-2
80	1.61-2	1.73-2	1.71-2	1.82-2	1.86-2	1.73-2	1.67-2	1.49-2
100	9.28-3	8.96-3	9.11-3	1.16-2	1.04-2	1.00-2	9.43-3	8.23-3
120	4.70-3	5.66-3	5.54-3	8.45-3	8.29-3	8.10-3	7.80-3	6.76-3
140	7.59-3	8.70-3	9.55-3	1.22-2	1.29-2	1.25-2	1.11-2	8.63-3
150	1.98-2	2.02-2	2.33-2	2.37-2	2.14-2	1.94-2	1.58-2	1.09-2
160	3.91-2	3.91-2	3.63-2	4.24-2	3.45-2	2.89-2	2.11-2	1.30-2
170	5.15-2	4.77-2	3.98-2	4.00-2	2.99-2	2.30-2	1.68-2	1.06-2
175	6.35-2	5.30-2	4.26-2	3.79-2	2.41-2	1.87-2	1.51-2	1.04-2
180	6.19-2	5.79-2	4.72-2	5.40-2	3.54-2	2.74-2	1.98-2	1.18-2

Table L3. Legendre Coefficients of Phase Functions

Index	Wavelength ( $\mu\text{m}$ )							
	0.40	0.44	0.55	0.75	1.04	1.24	1.65	2.20
0	1.00 0	1.00 0	1.00 0	1.00 0	1.00 0	1.00 0	1.00 0	1.00 0
1	2.29 0	2.28 0	2.26 0	2.17 0	2.19 0	2.23 0	2.27 0	2.35 0
2	3.36 0	3.32 0	3.28 0	3.13 0	3.07 0	3.07 0	3.06 0	3.09 0
3	3.61 0	3.56 0	3.47 0	3.25 0	3.14 0	3.14 0	3.10 0	3.14 0
4	4.30 0	4.23 0	4.04 0	3.70 0	3.39 0	3.26 0	3.06 0	2.96 0
5	4.51 0	4.44 0	4.19 0	3.73 0	3.31 0	3.11 0	2.79 0	2.60 0
6	5.09 0	4.96 0	4.59 0	4.00 0	3.31 0	2.99 0	2.51 0	2.20 0
7	5.42 0	5.29 0	4.87 0	4.15 0	3.27 0	2.85 0	2.25 0	1.84 0
8	5.80 0	5.63 0	5.08 0	4.20 0	3.14 0	2.63 0	1.95 0	1.49 0
9	6.17 0	5.97 0	5.33 0	4.34 0	3.09 0	2.51 0	1.74 0	1.22 0
10	6.47 0	6.19 0	5.41 0	4.29 0	2.89 0	2.28 0	1.48 0	9.75-1
11	6.76 0	6.46 0	5.58 0	4.32 0	2.81 0	2.15 0	1.31 0	7.94-1
12	6.95 0	6.63 0	5.62 0	4.20 0	2.61 0	1.93 0	1.11 0	6.28-1
13	7.14 0	6.80 0	5.67 0	4.14 0	2.49 0	1.79 0	9.71-1	5.07-1
14	7.34 0	6.91 0	5.69 0	3.99 0	2.31 0	1.60 0	8.25-1	3.99-1
15	7.42 0	6.96 0	5.62 0	3.86 0	2.18 0	1.47 0	7.14-1	3.17-1
16	7.53 0	7.03 0	5.58 0	3.70 0	2.00 0	1.32 0	6.10-1	2.49-1
17	7.57 0	7.01 0	5.47 0	3.55 0	1.85 0	1.18 0	5.20-1	1.92-1
18	7.65 0	7.03 0	5.41 0	3.41 0	1.70 0	1.06 0	4.48-1	1.50-1
19	7.63 0	6.98 0	5.33 0	3.24 0	1.55 0	9.44-1	3.76-1	1.10-1
20	7.62 0	6.94 0	5.21 0	3.12 0	1.44 0	8.53-1	3.26-1	8.60-2
21	7.59 0	6.86 0	5.11 0	2.94 0	1.31 0	7.47-1	2.68-1	5.91-2
22	7.53 0	6.75 0	4.92 0	2.82 0	1.21 0	6.79-1	2.35-1	4.77-2
23	7.48 0	6.66 0	4.77 0	2.65 0	1.09 0	5.84-1	1.88-1	3.02-2
24	7.37 0	6.52 0	4.59 0	2.52 0	1.01 0	5.35-1	1.66-1	2.62-2
25	7.29 0	6.42 0	4.43 0	2.36 0	8.97-1	4.54-1	1.28-1	1.41-2
26	7.15 0	6.29 0	4.31 0	2.22 0	8.36-1	4.18-1	1.14-1	1.37-2
27	7.05 0	6.18 0	4.15 0	2.07 0	7.44-1	3.52-1	8.31-2	5.11-3
28	6.91 0	6.04 0	4.03 0	1.95 0	6.92-1	3.23-1	7.55-2	6.26-3
29	6.81 0	5.91 0	3.86 0	1.80 0	6.14-1	2.72-1	5.10-2	1.10-3
30	6.66 0	5.75 0	3.72 0	1.70 0	5.66-1	2.48-1	4.75-2	2.30-3
31	6.55 0	5.60 0	3.57 0	1.56 0	4.99-1	2.07-1	2.81-2	2.45-5
32	6.40 0	5.43 0	3.41 0	1.47 0	4.55-1	1.89-1	2.65-2	2.99-4
33	6.26 0	5.27 0	3.29 0	1.35 0	3.97-1	1.55-1	1.22-2	-3.16-4
34	6.10 0	5.10 0	3.14 0	1.27 0	3.61-1	1.41-1	1.20-2	-5.25-4
35	5.95 0	4.95 0	3.03 0	1.18 0	3.14-1	1.13-1	3.34-3	-2.83-4
36	5.79 0	4.80 0	2.89 0	1.11 0	2.87-1	1.03-1	4.52-3	-7.45-5
37	5.64 0	4.66 0	2.78 0	1.03 0	2.49-1	8.10-2	4.49-4	2.83-4
38	5.48 0	4.50 0	2.65 0	9.61-1	2.27-1	7.27-2	2.00-3	5.82-4
39	5.34 0	4.36 0	2.52 0	8.91-1	1.97-1	5.52-2	1.57-4	4.12-4
40	5.18 0	4.20 0	2.41 0	8.32-1	1.79-1	4.85-2	8.19-4	1.61-4
41	5.05 0	4.05 0	2.29 0	7.68-1	1.53-1	3.49-2	-8.40-5	-1.38-4
42	4.89 0	3.91 0	2.19 0	7.15-1	1.38-1	2.99-2	4.28-6	-3.72-4
43	4.77 0	3.76 0	2.10 0	6.56-1	1.14-1	2.08-2	-6.00-5	-1.39-4
44	4.61 0	3.63 0	2.00 0	6.08-1	1.03-1	1.80-2	2.48-4	1.90-4
45	4.49 0	3.50 0	1.91 0	5.57-1	8.30-2	1.20-2	3.96-4	4.68-4
46	4.35 0	3.38 0	1.81 0	5.15-1	7.48-2	1.10-2	5.69-4	6.55-4
47	4.23 0	3.26 0	1.72 0	4.71-1	5.85-2	6.18-3	3.55-4	4.17-4
48	4.09 0	3.14 0	1.63 0	4.36-1	5.28-2	5.95-3	1.16-4	1.14-4
49	3.97 0	3.04 0	1.55 0	3.99-1	4.10-2	2.49-3	2.38-5	-4.68-5
50	3.84 0	2.92 0	1.47 0	3.68-1	3.82-2	2.76-3	1.34-5	-9.18-5

Table L3. Continued

Index	Wavelength ( $\mu\text{m}$ )							
	0.40	0.44	0.55	0.75	1.04	1.24	1.65	2.20
51	3.71 0	2.82 0	1.39 0	3.36-1	2.89-2	1.11-3	2.36-4	1.36-4
52	3.59 0	2.71 0	1.32 0	3.09-1	2.79-2	1.39-3	4.61-4	3.80-4
53	3.47 0	2.60 0	1.25 0	2.80-1	1.86-2	5.26-4	3.52-4	3.31-4
54	3.35 0	2.50 0	1.19 0	2.56-1	1.81-2	3.02-4	1.86-4	1.76-4
55	3.24 0	2.40 0	1.12 0	2.29-1	9.73-3	-1.14-4	-8.21-5	-8.48-5
56	3.13 0	2.30 0	1.07 0	2.10-1	9.77-3	-2.24-4	-2.45-4	-2.74-4
57	3.02 0	2.21 0	9.99-1	1.86-1	4.51-3	-3.85-6	2.10-6	-7.44-5
58	2.92 0	2.11 0	9.50-1	1.74-1	5.31-3	3.50-4	3.27-4	2.09-4
59	2.82 0	2.03 0	8.88-1	1.53-1	2.33-3	4.27-4	4.72-4	3.50-4
60	2.72 0	1.94 0	8.43-1	1.45-1	3.03-3	4.32-4	4.55-4	3.30-4
61	2.62 0	1.86 0	7.84-1	1.26-1	7.62-4	-1.23-4	-7.07-5	-1.50-4
62	2.54 0	1.79 0	7.46-1	1.18-1	9.11-4	-7.09-4	-6.48-4	-6.67-4
63	2.44 0	1.70 0	6.92-1	1.01-1	-3.80-4	-8.02-4	-7.49-4	-7.53-4
64	2.35 0	1.64 0	6.60-1	9.40-2	1.62-4	-7.01-4	-6.39-4	-5.98-4
65	2.25 0	1.56 0	6.12-1	7.89-2	7.24-5	6.44-6	3.53-5	5.95-5
66	2.18 0	1.51 0	5.84-1	7.32-2	8.40-4	7.05-4	6.96-4	6.90-4
67	2.08 0	1.44 0	5.40-1	5.99-2	5.70-4	6.64-4	6.41-4	6.39-4
68	2.01 0	1.39 0	5.14-1	5.44-2	2.30-4	3.77-4	3.20-4	2.91-4
69	1.92 0	1.32 0	4.73-1	4.33-2	-4.21-4	-4.06-4	-4.74-4	-4.96-4
70	1.86 0	1.27 0	4.49-1	3.90-2	-1.12-3	-1.16-3	-1.20-3	-1.17-3
71	1.77 0	1.21 0	4.14-1	3.10-2	-7.50-4	-8.67-4	-9.38-4	-9.17-4
72	1.71 0	1.16 0	3.93-1	2.94-2	-1.21-4	-3.59-4	-3.96-4	-3.31-4
73	1.63 0	1.11 0	3.63-1	2.30-2	6.98-4	5.85-4	5.31-4	6.07-4
74	1.58 0	1.06 0	3.45-1	2.28-2	1.53-3	1.39-3	1.32-3	1.36-3
75	1.50 0	1.01 0	3.18-1	1.59-2	1.07-3	1.08-3	1.01-3	1.06-3
76	1.45 0	9.62-1	3.00-1	1.53-2	4.63-4	5.40-4	4.27-4	4.40-4
77	1.38 0	9.13-1	2.75-1	8.92-3	-2.58-4	-2.04-4	-3.26-4	-3.47-4
78	1.32 0	8.72-1	2.60-1	8.81-3	-8.30-4	-7.64-4	-8.90-4	-8.91-4
79	1.26 0	8.25-1	2.39-1	5.13-3	-1.52-4	-2.21-4	-3.41-4	-3.94-4
80	1.21 0	7.90-1	2.26-1	6.39-3	6.50-4	5.18-4	4.18-4	3.73-4
81	1.16 0	7.46-1	2.08-1	4.01-3	1.31-3	1.15-3	1.07-3	1.04-3
82	1.11 0	7.15-1	1.96-1	4.94-3	1.74-3	1.59-3	1.51-3	1.44-3
83	1.06 0	6.74-1	1.79-1	2.08-3	1.06-3	1.01-3	9.40-4	9.03-4
84	1.01 0	6.46-1	1.67-1	2.05-3	3.25-4	3.64-4	2.79-4	2.18-4
85	9.64-1	6.09-1	1.52-1	1.30-5	-2.07-5	3.49-5	-6.08-5	-1.51-4
86	9.26-1	5.83-1	1.41-1	6.77-4	-1.37-4	-1.93-5	-1.37-4	-2.38-4
87	8.81-1	5.51-1	1.29-1	2.29-4	5.40-4	5.35-4	4.07-4	2.80-4
88	8.47-1	5.28-1	1.20-1	1.30-3	1.08-3	1.10-3	9.55-4	8.04-4
89	8.05-1	4.99-1	1.08-1	8.75-4	1.00-3	9.39-4	8.21-4	7.10-4
90	7.72-1	4.75-1	9.98-2	6.49-4	6.52-4	5.85-4	4.76-4	3.74-4
91	7.32-1	4.48-1	8.87-2	1.08-4	2.00-6	-1.82-5	-1.15-4	-1.83-4
92	7.01-1	4.25-1	8.18-2	-4.46-4	-4.33-4	-4.65-4	-5.40-4	-5.67-4
93	6.65-1	4.01-1	7.27-2	9.91-5	-3.74-5	-1.56-5	-9.82-5	-1.42-4
94	6.37-1	3.80-1	6.79-2	6.59-4	5.72-4	6.06-4	5.24-4	4.63-4
95	6.03-1	3.57-1	5.95-2	1.06-3	8.94-4	9.07-4	8.30-4	7.72-4
96	5.77-1	3.38-1	5.52-2	1.13-3	9.02-4	9.45-4	8.40-4	7.40-4
97	5.44-1	3.14-1	4.65-2	2.33-4	-6.95-5	-5.84-5	-1.58-4	-2.34-4
98	5.20-1	2.97-1	4.25-2	-8.53-4	-1.17-3	-1.19-3	-1.26-3	-1.29-3
99	4.90-1	2.75-1	3.50-2	-9.69-4	-1.38-3	-1.37-3	-1.45-3	-1.49-3
100	4.68-1	2.62-1	3.35-2	-8.75-4	-1.14-3	-1.23-3	-1.25-3	-1.20-3

Table L3. Concluded

Index	Wavelength ( $\mu\text{m}$ )							
	0.40	0.44	0.55	0.75	1.04	1.24	1.65	2.20
101	4.42-1	2.43-1	2.79-2	4.66-4	1.01-4	6.60-5	4.35-5	8.71-5
102	4.24-1	2.32-1	2.79-2	1.62-3	1.43-3	1.33-3	1.31-3	1.32-3
103	3.99-1	2.15-1	2.15-2	1.55-3	1.30-3	1.23-3	1.21-3	1.26-3
104	3.81-1	2.03-1	2.02-2	1.00-3	7.27-4	6.77-4	6.06-4	6.02-4
105	3.56-1	1.86-1	1.32-2	-5.52-4	-7.46-4	-8.02-4	-8.96-4	-9.09-4
106	3.39-1	1.75-1	1.19-2	-1.79-3	-2.12-3	-2.19-3	-2.28-3	-2.23-3
107	3.18-1	1.62-1	7.60-3	-1.49-3	-1.60-3	-1.70-3	-1.82-3	-1.83-3
108	3.04-1	1.53-1	9.01-3	-5.07-4	-5.83-4	-7.82-4	-8.57-4	-8.08-4
109	2.86-1	1.43-1	6.63-3	1.00-3	1.10-3	8.93-4	8.28-4	8.86-4
110	2.74-1	1.35-1	8.56-3	2.27-3	2.60-3	2.34-3	2.27-3	2.27-3
111	2.54-1	1.24-1	4.61-3	1.64-3	1.99-3	1.74-3	1.69-3	1.76-3
112	2.41-1	1.15-1	4.34-3	4.22-4	9.39-4	7.69-4	6.59-4	6.71-4
113	2.23-1	1.03-1	2.13-4	-8.22-4	-3.76-4	-5.80-4	-7.16-4	-7.28-4
114	2.11-1	9.54-2	3.20-4	-1.89-3	-1.43-3	-1.57-3	-1.73-3	-1.71-3
115	1.97-1	8.53-2	-9.52-4	-7.02-4	-3.46-4	-5.95-4	-7.87-4	-8.47-4
116	1.88-1	8.18-2	1.37-3	6.55-4	9.66-4	7.20-4	5.38-4	4.84-4
117	1.76-1	7.24-2	7.36-4	2.02-3	2.16-3	1.85-3	1.69-3	1.67-3
118	1.67-1	6.94-2	2.15-3	2.85-3	2.88-3	2.64-3	2.47-3	2.40-3
119	1.54-1	5.90-2	-2.28-4	1.90-3	1.83-3	1.64-3	1.49-3	1.51-3
120	1.45-1	5.49-2	-6.97-4	8.57-4	5.94-4	5.37-4	3.62-4	3.68-4
121	1.33-1	4.61-2	-2.12-3	1.19-4	-1.45-5	-3.69-5	-2.21-4	-2.42-4
122	1.25-1	4.34-2	-1.46-3	8.89-5	-2.01-4	-1.40-4	-3.55-4	-3.77-4
123	1.15-1	3.74-2	-7.42-4	8.52-4	7.90-4	8.23-4	5.83-4	5.09-4
124	1.09-1	3.59-2	6.78-4	1.84-3	1.73-3	1.78-3	1.53-3	1.41-3
125	9.95-2	2.99-2	4.76-4	1.55-3	1.50-3	1.59-3	1.34-3	1.26-3

# Appendix M

## 13-Month Post-Eruption Stratospheric Aerosol Model

Table M1. Optical Parameters

Wavelength ( $\mu\text{m}$ )	Extinction Cross Section ( $\text{m}^2$ )	Asymmetry Factor	Single Scattering Albedo	180 Degree Backscatter ( $\text{m}^2/\text{sr}$ )	Refractive Indices	
0.40	1.34-12	0.726	1.000	7.11-14	1.44	-1.00-8
0.44	1.30-12	0.702	1.000	6.82-14	1.44	-1.00-8
0.55	1.25-12	0.657	1.000	5.24-14	1.43	-1.00-8
0.75	1.65-12	0.724	1.000	4.37-14	1.43	-7.36-8
1.04	1.85-12	0.781	1.000	2.82-14	1.42	-1.37-6
1.24	1.66-12	0.783	1.000	2.13-14	1.41	-7.88-6
1.65	1.11-12	0.751	1.000	1.30-14	1.40	-3.15-4
2.20	5.76-13	0.685	0.987	6.67-15	1.37	-1.69-3

Table M2. Phase Functions

Scatter Angle (deg)	Wavelength ( $\mu\text{m}$ )							
	0.40	0.44	0.55	0.75	1.04	1.24	1.65	2.20
0	6.95 0	5.87 0	3.56 0	2.51 0	1.78 0	1.40 0	9.05-1	5.81-1
1	6.85 0	5.80 0	3.53 0	2.50 0	1.78 0	1.40 0	9.04-1	5.80-1
2	6.55 0	5.58 0	3.44 0	2.47 0	1.77 0	1.39 0	9.02-1	5.79-1
4	5.49 0	4.80 0	3.10 0	2.34 0	1.72 0	1.36 0	8.91-1	5.75-1
6	4.12 0	3.74 0	2.61 0	2.14 0	1.64 0	1.32 0	8.74-1	5.69-1
8	2.78 0	2.66 0	2.05 0	1.90 0	1.54 0	1.26 0	8.51-1	5.59-1
10	1.74 0	1.75 0	1.52 0	1.63 0	1.43 0	1.19 0	8.22-1	5.48-1
15	5.43-1	5.44-1	5.92-1	9.58-1	1.06 0	9.59-1	7.17-1	5.01-1
20	3.18-1	2.91-1	2.98-1	5.25-1	7.46-1	7.43-1	6.19-1	4.60-1
40	1.02-1	1.12-1	1.42-1	1.29-1	1.08-1	1.40-1	2.11-1	2.37-1
60	4.41-2	4.75-2	5.43-2	4.49-2	3.63-2	3.34-2	4.83-2	8.71-2
80	2.03-2	2.23-2	2.46-2	1.94-2	1.56-2	1.52-2	1.57-2	2.85-2
100	1.09-2	1.18-2	1.35-2	1.13-2	8.83-3	8.53-3	9.53-3	1.14-2
120	6.95-3	8.32-3	1.07-2	9.95-3	7.13-3	7.15-3	7.72-3	6.93-3
140	1.17-2	1.43-2	1.77-2	1.31-2	1.12-2	9.04-3	6.90-3	7.22-3
150	2.32-2	2.39-2	2.66-2	2.47-2	1.28-2	8.83-3	7.39-3	8.48-3
160	4.50-2	5.41-2	6.31-2	2.98-2	1.11-2	8.88-3	8.93-3	1.00-2
170	5.24-2	4.53-2	3.02-2	1.75-2	1.23-2	1.11-2	1.08-2	1.12-2
175	2.87-2	2.92-2	2.86-2	2.21-2	1.43-2	1.23-2	1.15-2	1.16-2
180	5.28-2	5.22-2	4.17-2	2.65-2	1.52-2	1.29-2	1.17-2	1.17-2

Table M3. Legendre Coefficients of Phase Functions

Index	Wavelength ( $\mu\text{m}$ )							
	0.40	0.44	0.55	0.75	1.04	1.24	1.65	2.20
0	1.00 0	1.00 0	1.00 0	1.00 0	1.00 0	1.00 0	1.00 0	1.00 0
1	2.18 0	2.11 0	1.97 0	2.17 0	2.34 0	2.35 0	2.25 0	2.06 0
2	3.20 0	3.06 0	2.73 0	2.98 0	3.16 0	3.06 0	2.65 0	2.00 0
3	3.38 0	3.14 0	2.54 0	3.03 0	3.30 0	3.06 0	2.26 0	1.26 0
4	4.06 0	3.75 0	2.82 0	3.14 0	3.16 0	2.69 0	1.58 0	6.38-1
5	4.18 0	3.83 0	2.74 0	3.02 0	2.78 0	2.11 0	8.96-1	2.39-1
6	4.59 0	4.19 0	2.87 0	2.87 0	2.23 0	1.46 0	4.52-1	7.91-2
7	4.72 0	4.32 0	2.98 0	2.74 0	1.69 0	8.97-1	1.82-1	2.17-2
8	4.82 0	4.39 0	2.94 0	2.38 0	1.15 0	5.09-1	7.25-2	5.79-3
9	4.89 0	4.48 0	3.07 0	2.15 0	7.16-1	2.41-1	2.36-2	1.42-3
10	4.78 0	4.30 0	2.81 0	1.70 0	4.30-1	1.22-1	8.49-3	3.84-4
11	4.78 0	4.30 0	2.85 0	1.37 0	2.12-1	4.85-2	2.47-3	6.05-5
12	4.49 0	3.95 0	2.44 0	1.02 0	1.22-1	2.37-2	7.56-4	-7.33-5
13	4.42 0	3.87 0	2.33 0	7.00-1	4.96-2	8.04-3	3.89-5	-1.04-4
14	4.03 0	3.42 0	1.91 0	5.07-1	2.94-2	3.98-3	-7.92-5	-4.97-5
15	3.89 0	3.26 0	1.65 0	2.79-1	1.05-2	1.03-3	2.47-5	5.30-5
16	3.44 0	2.79 0	1.32 0	2.09-1	6.88-3	2.55-4	1.51-4	1.32-4
17	3.25 0	2.55 0	9.99-1	9.04-2	2.39-3	-3.62-4	1.37-4	1.19-4
18	2.81 0	2.15 0	8.32-1	8.67-2	1.52-3	-1.28-4	4.05-5	7.42-6
19	2.55 0	1.84 0	5.41-1	3.18-2	-1.11-4	2.54-4	-1.12-4	-1.32-4
20	2.18 0	1.56 0	4.91-1	3.70-2	-1.64-5	3.26-4	-2.01-4	-1.91-4
21	1.87 0	1.21 0	2.65-1	1.25-2	-3.15-4	1.82-4	-6.76-5	-8.55-5
22	1.61 0	1.05 0	2.59-1	1.59-2	-5.37-5	-1.55-4	1.53-4	1.09-4
23	1.29 0	7.29-1	1.04-1	4.05-3	5.17-4	-4.25-4	2.76-4	2.42-4
24	1.12 0	6.54-1	1.11-1	4.00-3	2.83-4	-1.74-4	1.96-4	2.05-4
25	8.20-1	4.06-1	2.81-2	-1.43-4	-1.88-4	1.96-4	-1.50-4	-4.06-5
26	7.37-1	3.94-1	4.55-2	-1.52-5	-3.44-4	1.75-4	-4.24-4	-3.37-4
27	4.89-1	2.25-1	1.14-2	-1.03-4	-4.54-4	-3.00-5	-3.59-4	-4.65-4
28	4.59-1	2.39-1	2.49-2	6.72-4	-1.93-4	-2.06-4	-1.39-4	-3.18-4
29	2.84-1	1.31-1	1.02-2	6.25-4	2.74-4	-1.78-4	1.85-4	1.20-4
30	2.81-1	1.44-1	1.28-2	9.10-4	3.35-4	3.54-5	4.01-4	5.17-4
31	1.66-1	7.47-2	3.99-3	3.12-4	1.52-4	1.80-4	3.02-4	5.34-4
32	1.71-1	8.20-2	2.33-3	-1.18-4	-8.73-5	1.77-4	7.50-5	2.32-4
33	9.24-2	3.64-2	-9.04-4	-4.91-4	-4.18-4	-6.43-5	-2.75-4	-3.21-4
34	9.81-2	4.21-2	-4.19-4	-6.98-4	-4.54-4	-3.13-4	-5.74-4	-7.44-4
35	4.45-2	1.41-2	3.80-4	-4.18-4	-1.81-4	-2.91-4	-4.72-4	-6.47-4
36	5.14-2	2.09-2	2.00-3	7.50-5	4.86-5	-1.71-4	-1.40-4	-1.95-4
37	1.94-2	6.21-3	2.20-3	4.07-4	3.42-4	1.23-4	3.34-4	4.58-4
38	2.58-2	1.09-2	2.12-3	6.76-4	4.19-4	4.11-4	6.94-4	8.95-4
39	1.08-2	5.17-3	6.76-4	4.18-4	1.71-4	3.50-4	5.24-4	6.75-4
40	1.32-2	5.50-3	-3.20-4	-3.43-5	-2.96-6	2.16-4	9.37-5	9.90-5
41	7.41-3	4.05-3	-8.02-4	-3.37-4	-2.02-4	-4.51-5	-3.89-4	-5.52-4
42	6.87-3	2.57-3	-7.02-4	-5.06-4	-2.45-4	-3.13-4	-6.54-4	-8.95-4
43	4.37-3	2.25-3	3.21-4	-1.81-4	4.68-5	-1.73-4	-3.63-4	-5.37-4
44	4.26-3	1.98-3	1.13-3	3.69-4	2.48-4	8.19-5	1.30-4	1.19-4
45	2.79-3	1.37-3	1.30-3	6.63-4	4.12-4	3.56-4	5.27-4	6.87-4
46	3.61-3	1.90-3	1.19-3	7.95-4	4.90-4	6.15-4	6.98-4	8.86-4
47	2.67-3	1.24-3	1.91-4	4.94-4	2.32-4	4.65-4	3.74-4	4.22-4
48	2.79-3	1.27-3	-4.20-4	5.25-5	6.62-5	1.98-4	-5.00-5	-2.09-4
49	2.45-3	1.35-3	-4.58-4	-7.60-5	1.68-5	3.75-5	-2.69-4	-5.50-4
50	2.04-3	1.16-3	-1.51-4	-5.65-5	3.61-5	-4.58-5	-2.64-4	-4.69-4

Table M3. Concluded

Index	Wavelength ( $\mu\text{m}$ )							
	0.40	0.44	0.55	0.75	1.04	1.24	1.65	2.20
51	1.91-3	1.33-3	5.41-4	2.07-4	2.89-4	1.34-4	8.20-5	7.76-5
52	1.87-3	1.20-3	9.52-4	5.47-4	4.85-4	3.47-4	4.22-4	6.03-4
53	1.30-3	5.64-4	6.88-4	5.44-4	4.04-4	3.04-4	3.85-4	5.93-4
54	1.40-3	3.33-4	3.02-4	3.83-4	2.32-4	2.00-4	1.49-4	1.89-4
55	6.95-4	-2.37-4	-2.83-4	4.51-5	-2.61-5	-3.99-6	-2.04-4	-4.05-4
56	7.77-4	-1.16-4	-5.20-4	-3.30-4	-1.95-4	-1.84-4	-4.03-4	-7.18-4
57	7.41-4	2.29-4	-1.33-4	-1.13-4	-3.73-6	-2.67-5	-8.33-5	-3.16-4
58	9.49-4	7.11-4	3.85-4	2.15-4	2.74-4	1.65-4	3.63-4	4.06-4
59	1.02-3	8.94-4	6.59-4	3.44-4	4.10-4	2.14-4	6.06-4	9.09-4
60	7.92-4	7.40-4	6.61-4	4.08-4	3.98-4	1.83-4	5.13-4	8.70-4
61	1.92-4	9.17-6	4.55-6	-1.37-4	-6.73-5	-2.60-4	-1.95-4	-1.95-5
62	-3.77-4	-6.81-4	-7.50-4	-7.44-4	-5.86-4	-7.21-4	-9.35-4	-1.08-3
63	-7.07-4	-9.45-4	-9.10-4	-8.23-4	-7.00-4	-7.65-4	-1.09-3	-1.45-3
64	-5.12-4	-7.30-4	-8.13-4	-7.72-4	-6.54-4	-6.40-4	-7.70-4	-1.04-3
65	8.30-6	3.64-5	1.74-5	-8.44-5	-1.17-4	-3.75-5	2.16-4	2.64-4
66	6.56-4	8.70-4	8.76-4	6.25-4	4.30-4	5.43-4	1.11-3	1.52-3
67	7.23-4	1.00-3	8.32-4	5.18-4	3.45-4	4.70-4	1.11-3	1.65-3
68	3.48-4	6.35-4	4.69-4	2.43-4	1.02-4	1.81-4	5.05-4	8.14-4
69	-2.49-4	-1.12-4	-4.60-4	-5.96-4	-5.58-4	-5.28-4	-6.81-4	-8.21-4
70	-9.87-4	-1.07-3	-1.45-3	-1.35-3	-1.17-3	-1.16-3	-1.65-3	-2.16-3
71	-7.55-4	-8.55-4	-1.08-3	-1.02-3	-9.14-4	-8.90-4	-1.42-3	-1.98-3
72	-2.13-4	-4.20-4	-4.96-4	-4.50-4	-4.77-4	-3.79-4	-5.33-4	-7.62-4
73	5.83-4	5.16-4	6.11-4	5.45-4	2.97-4	4.74-4	7.98-4	1.05-3
74	1.39-3	1.39-3	1.64-3	1.41-3	1.00-3	1.22-3	1.78-3	2.33-3
75	1.14-3	1.16-3	1.21-3	1.05-3	7.42-4	9.58-4	1.38-3	1.86-3
76	6.36-4	6.38-4	5.59-4	4.61-4	3.34-4	4.64-4	3.66-4	4.20-4
77	6.38-5	-3.22-5	-3.12-4	-3.26-4	-2.38-4	-2.09-4	-8.53-4	-1.27-3
78	-4.42-4	-6.50-4	-1.05-3	-9.09-4	-6.89-4	-7.53-4	-1.60-3	-2.20-3
79	1.24-4	-9.73-5	-3.15-4	-2.68-4	-1.90-4	-3.04-4	-9.70-4	-1.37-3



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